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TO ADVERTISERS

CHANGES for advertisements should be in this office by Friday noon for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than Monday noon to ensure publication in that week's issue.

OUR TWENTIETH ANNIVERSARY.

The next issue of the ELECTRICAL REVIEW, dated February 15, will mark the twentieth anniversary of the publication of this journal.

The issue will be of a special character commemorating this occasion, and will contain, among other articles of great merit and interest, a history of the journal itself, a study of the evolution of electrical industry and progress during the period of time covered by its publication, and a number of exceedingly interesting and valuable reminiscences and sketches by several of the most notable living American electricians and engineers. In addition to this matter of special character, there will be an unusually full and interesting collection of descriptive and illustrated articles, dealing with both European and American practice in the various branches of the art.

MR. CARNEGIE'S GIFT TO THE FUTURE.

At Washington on Wednesday, January 29, in the presence of a small but notable gathering of American men of science, educators, statesmen and leading spirits in public affairs, Mr. Andrew Carnegie made a gift of ten million dollars to found an institute for the promotion of scientific research.

The nature of the foundation as defined by the trust deed makes it in many ways closely similar to the Royal Institution in London and the College de France in Paris. Its object is perhaps best stated in a single sentence quoted from the trust deed: "To discover the exceptional man in every department of study, whenever and wherever found, inside or outside of schools, and to enable him to make the work for which he seems especially designed his life work."

In other words, Mr. Carnegie has established an institution for the production of men of science, an establishment which, on account of the munificent generosity of its founder, will enable such men to live independent of the cares which ordinarily surround investigators and will give them that leisure so absolutely necessary for the pursuit of pure science. This country, despite its extraordinary advance in engineering and all that is included in the general term of applied science, has yet had to bear, in some degree, the reproach of producing no names of absolutely illustrious merit in the field of science. We have fathered a race of engineers whose works have reflected the highest possible credit upon their country, but we have left to other nations the production in this generation of such men as Maxwell, Helmholtz, Darwin and Herbert Spencer. One reason is found in the absence hitherto of such an institution as Mr. Carnegie has founded.

It seems impossible for any one to doubt that, given the same opportunity and the same environment, our national character will certainly produce investigators of an originality and power comparable to those who have distinguished the last century of progress in science abroad. For this reason, because he has endowed the future with a capacity so great that it is not possible for us now to see even dimly the extent of its outreach, Mr. Carnegie has probably done the greatest work for education and for advancement that has ever been done by any individual. Resisting the desire to found another university which, in the nature of things, could only be a competitor of existing institutions of learning, he has put at the public service a vast sum of money to be applied directly where it is most needed—in the development of the kind of men around whom universities will in the future crystallize.

MUNICIPAL OWNERSHIP.

On other pages of this issue will be found a report made by a committee of the board of aldermen of Worcester, Mass., concerning the question of establishing a municipal electric light plant in that city. The report is luminous with good, sound, old-fashioned common sense.

Contrary to the usual habit of municipal governments, that of the city of Worcester undertook carefully to investigate the subject before committing taxpayers to an investment. The result was that the investigating committee discovered many things of interest and incorporated them in its report, which makes excellent reading. The peculiar hallucination of municipal ownership seems to afflict communities in this country periodically. Probably there is no city of between ten thousand and one hundred thousand inhabitants which has not already undergone at least one period of agitation in favor of municipal ownership of electric lighting plants. Just why this particular business has been seized upon for the exploitation of socialistic theories is hard to find out. The majority of aldermen and

councilors understand the grocery business, or think they do, and it would seem that this widespread, necessary and important branch of trade might claim their attention rather than electric lighting, which they know nothing about and which has the further disadvantage of being a business requiring very expert management. Yet, so far as we know, there has been no movement made anywhere to establish the grocery business on lines of municipal ownership. The whole thing is a dark mystery, and the only really pleasing thing about it is that cities afflicted with the agitation recover their senses after a time—slowly if the plant is not erected, very swiftly and repentantly if it is.

MATHEMATICAL ANALYSIS OF ELECTRIC RAILWAYS.

The interesting paper by Dr. Cary T. Hutchinson, read before the last meeting of the American Institute of Electrical Engineers, is completed in this number and with it is given a short abstract of the discussion. It appears that nearly all those who spoke took issue in one way or the other with the conclusions which were reached in the paper itself, and the general result is that there appears to be no agreement in the matter of applying mathematical analysis to the problems presented by electrical railways.

Perhaps the most satisfactory conclusion to be drawn from this somewhat unhappy state of things is that the subject is one which will bear a good deal further discussion and much more investigation. Certainly, no one will deny its importance. There has been far too much haphazard and rule-of-thumb building of electric railways already. So long as this was confined to trolley roads where the accumulated experience of years might help, the results were generally not remarkably bad. But when it is attempted to extend empirical methods to the larger developments of the subject, difficulties are encountered at once and a general working theory of the relations between motive power and acceleration is found to be urgently needed. For this reason even those who have taken issue of the conclusion attended by Dr. Hutchinson must give him credit for having done important pioneer work in a direction of unusual difficulty.

THE FIRE HAZARD FROM GAS.

Among the innumerable subjects which have engaged the attention of sanitary departments and boards of health, one singularly grave menace to health and life as well as to property has been for the most part neglected. Within the last few years the custom of laying water-tight pavements has greatly extended in American cities. Beneath the pavements of streets are gas mains and the common experience of all gas companies is that these mains leak and leak continually. The gas escaping must find an outlet somewhere.

Following, as it generally does, the disturbed earth about service pipes, it enters the cellars of buildings, there accumulating either to form a dangerous explosive or inflammable mixture or ascending through the house to form a slow poison for its inmates. One of the most dangerous and distressing features about the whole subject is that ordinary earth filters perfectly from illuminating gas all of the elements which give that fluid its characteristic odor. When gas is found escaping from a pipe its odor is generally sufficient warning to warrant a complete discovery of the leak. But when it is filtering through several yards of earth the odor is eliminated, and only the poisonous and inflammable contents of the gas are left to escape and do serious damage.

In a paper just published in *Insurance Engineering* by Dr. James C. Bayles, who is competent to speak with great authority on matters concerning gas distribution systems, attention is called at length to the very serious dangers of fire damage arising from leaking gas. Some of the statistics given in this paper are of vital importance; for example, it is stated that the average leakage per mile of six-inch mains is 225,000 cubic feet. This is considered good gas engineering practice. In some cities, as notably in Glasgow, the leakage rises to enormous figures; in the latter city an official report shows an escape of gas equivalent to 1,642,207 cubic feet per mile. In New York city there are about 5,000 miles of gas mains in the borough of Manhattan alone, and from every section of each of these there is always some leakage.

Since the advent of asphalt pavements, the number of mysterious uncontrollable and sudden fires seems perceptibly to have increased. It has been almost the habit of fire marshals and other persons in authority to lay the whole blame of these conflagrations on electric wires. When the evidence of the cause of a fire is totally destroyed by the fire itself and there is no really convenient cause to which the conflagration may be ascribed, we hear of the electric wire. This practice has become so common and widespread as to cause a general feeling on the part of the public that electric light wiring is distinctly unsafe. While no one can doubt that fires have been caused by electric light conductors, still in the face of such statistics as are given above and seeing how perfectly leaking gas can explain the cause of many if not most mysterious fires, it seems that a word should be spoken on behalf of the most maligned wire. In the revision of the Underwriters' rules, which it is expected to make in the near future, it is to be hoped that more serviceable and liberal provisions will be made concerning wiring installation and that insurance people may be awakened to the dangers caused by the omnipresent gas pipe.

"ETHEROGRAM."

To the Editor of the Electrical Review:

I beg leave to suggest "Etherography" as a word for wireless telegraphy. The companion words, etherogram, etherograph and etherographist are euphonious and the derivation proper, the component parts being both from the Greek; αιθηρ, air, and γραφειν, to write.

Ether is defined in physics as "an hypothetical medium . . . supposed . . . to be the medium of transmission of light and heat" (and electricity).

Chas. Sidney Smith.

Decatur, Ill., January 29.

[We have received several interesting suggestions of this sort, and the evident interest displayed leads us to invite others to send in names—brief and euphonious. The term "wireless telegraphy" is not only too long and cumbersome, but is a misnomer as well. The name should be short, pronounceable, of irreproachable linguistic antecedents, and such as to be acceptable to those speaking languages other than English.—Eds.]

THE THEORY OF ALTERNATING DYNAMO ELECTRIC MECHANISMS—LV.

BY W. ELWELL GOLDSBOROUGH.

The positions taken by the vectors of Fig. 134 when $r_1 = 0$ are indicated by the exponent letters (k), and represent the values of the various factors when the machine is short-circuited. Accordingly, it will be found that the current vector OB^k occupies a phase position that is

$$\phi_0^k = \tan^{-1} \frac{x_a}{r_a}$$

degrees behind the vector OA_0. Owing to the small resistance of armature circuits, *in practice* this angle closely approximates 90°. The total electro-motive force in phase with the current is now reduced to the vector length $OC_a^k = I^k r_a$, and it is the only effective electro-motive force present in the coils of the machine at this time; for the current OB^k now produces a field intensity represented by the flux vector M_0M^k, that is very nearly equal and opposite to the field flux vector OM_0. The resultant of these vectors is, in fact, the short flux vector OM^k, which represents an amount of flux penetrating the armature coils that is just sufficient to develop the effective electro-motive force OC_a^k, which electro-motive force, in turn, is just sufficient to force the current OB^k through the resistance of the armature.

At the time of short-circuit, the reactance electro-motive force of the armature is necessarily high, on account of the large value of the armature current OB^k. OD_a, therefore, advances to the position OD_a^k, 90° in advance of the armature flux vector M_0M^k, to which it is due. The (k) positions of the vectors show us that the maximum angular displacement which the armature current can possibly have, relatively to the total internal electro-motive force, is something less than 90°, depending upon the relative magnitude of the resistance and inductance constants of the armature. When the armature is short-circuited, the electro-motive force at the collector rings is necessarily zero. The impedance of the electro-motive force of the armature OA_a must, consequently, be equal to the internal electro-motive force OA_0, or, at short-circuit, the vector head A_a moves to coincidence with the vector head A_0. This brings the heel C_a of the armature impedance triangle OA_aC_a to the position C_a^k, as already explained.

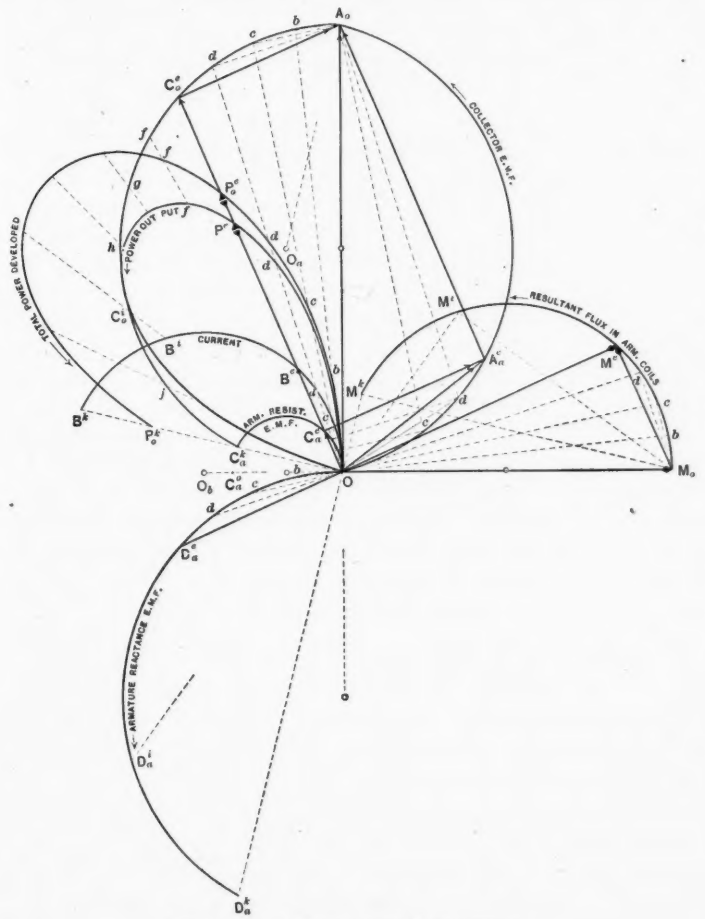


FIG. 134.—ALTERNATING MECHANISMS.

Now, the vector A_aA_0 is parallel to the vector OC_a, and, consequently, in phase with the vector OB. It is, therefore, at right angles to the reactance vector C_aA_a in all of its phase positions. Therefore, the extension of the reactance electro-motive-force vector C_aA_a will always pass through the point C_a^0, which is the extremity of the diameter of the locus circle $OC_a^eC_a^iC_a^k$ traced by the armature resistance electro-motive-force vector head.

Now, since, as has been shown, the reactance electro-motive-force vector C_aA_a is always in line with the point C_a^0, and at right angles to the vector A_aA_0, the point A_a must trace out a locus which is a semi-circle, and which may be described on the line $C_a^0A_0$ as a diameter. Therefore, the collector electro-motive force traces out a locus that is the arc of a circle when the value of r_1 is varied. The centre of this locus, $A_a^cA_a^dA_a^e$, is at the point O_a.

The most pleasing point brought out by a consideration of the vector diagram shown in Fig. 134 is that descriptive of the way in which the magnetic flux, due to the armature current, automatically neutralizes the magnetic flux, due to the magnetic circuit, as the load comes on the machine. At first, the reaction of the armature against the magnetic circuit may seem to be a defect. As a matter of fact, it is one of the most valuable properties of the alternator, as, on account of it, the designer can adapt a machine to a large variety of special uses, and, as will be pointed out later, it is a property most valuable when used to promote a balance in transmission systems.

Electrical Goods in Siam.

There is a large and growing business, writes Consul-General Hamilton King, from Bangkok, in electrical goods to supply the tramway company, the electric light and power plant and the twenty-six private plants in the city. In this line, America has the great export of the market.

Tafel and Naumann have found that sulphuric acid solutions of strychnia and brucia give in the neighborhood of a lead cathode in closed vessels at a low temperature the tetrahydro-derivatives in crystals. Like methyl-strychnia, the new bases probably differ from the original alkaloids in physiological properties. Strychnidine and brucidine were also obtained, the latter indirectly. Quinine, cinchonine and cinchonidine were reduced, but did not give crystalline products.

Science Brevities

Magnetic Rotation of Certain Sugars—A paper by W. H. Perkin, in a recent number of the *Chem. Soc. Proceedings,* is directed to the cause of the birotation or multirotation of these polyhydric alcohols. It is shown that the property is not explained by simple hydration, but that an isomeric change occurs when the disaccharoses are dissolved in water. E. Fischer's structural formulæ are generally supported. As cane sugar may ultimately be synthesized electrolytically, every point that can be cleared in the electrical properties of the group is of value.

Electromagnetic Theory — An abstract from *Comptes Rendus,* in the *Electrician,* states that in connection with the problem presented by Barlow's wheel, E. Carvallo has formulated what he calls the three laws of electric inertia, as follows: (1) A non-magnetic conducting element with a current, *p,* in a magnetic field, *a,* undergoes an electrodynamic force represented by the vector *p a;* (2) a non-magnetic conducting element moving through a magnetic field, *a,* with a velocity, *x,* carries an induced electro-motive force represented by the vector *x a;* (3) the induced electro-motive force within a closed curve is the sum of the two terms, one of which is the integral of the vector, *x a,* along the curve, and the other the derivative of the magnetic flux traversing the curve, but reversed in sign. Among the experimental proofs suggested by the author, one consists in replacing Barlow's wheel by a wheel of soft iron, when the electrodynamic force applied to the wheel will be increased on account of the magnetic induction in the soft iron. At the same time, the electro-motive force induced by the rotation is also increased. No theory of Barlow's wheel is complete unless it explains the fact that the vertical spoke of the wheel behaves exactly like a conducting wire.

New Magnetic Vacuum Phenomena—H. Pellat has discovered, quotes Mr. Fournier d'Albe from *Comptes Rendus,* some novel phenomena presented by vacuum tubes three feet long and one-half inch wide when brought into a magnetic field. The tube is long enough for the electrodes to be beyond the influence of a magnet placed at the centre of the tube. The stratifications are observed to crowd together into the magnetic field, and new strata leave the anode to fill up the vacancies. At the same time the strata undergo a tilting about an axis parallel to the lines of force, and in such a manner that an observer placed in the axis of the tube and looking along the lines of force would see the strata sloping down on his left side and up on his right side. The best field strength to produce the phenomena is about 120 units. Another phenomenon is observed when the tube is passed through perforations in the poles of an electromagnet. If the portion between the poles is entirely filled with positive light then, on exciting the magnet, the beam of positive light is reduced to a narrow pencil passing along the axis of the tube. No change is produced by reversing the current or the field. The author attributes this phenomena to the magnetic properties of the gases concerned, which in these experiments were alcohol, oxygen or hydrogen mixed with nitrogen.

Photo-Electrics — The photo-electric properties of selenium offer striking possibilities to the student. In one of several experiments described by Mr. J. W. Giltay, a selenium cell is mounted in a drum resembling a fluoroscope, and is placed in circuit with a telephone, when intermittent illumination of the selenium is made audible in tones of corresponding pitch. In another experiment, an acetylene flame is vibrated by speaking into a microphone, the vibrations being converted into sound by the selenium cell and telephone. This experiment is varied by enclosing the selenium cell in a box with three small incandescent lamps connected in series, these lamps being fed by sixteen accumulators and inserted in the secondary circuit of an induction coil with a carbon microphone in the primary circuit. Speaking into the microphone sets up vibrations of luminosity which are changed back into sound by the selenium cell.

Rectifiers for X-Ray Work—The difficulties in the way of working X-ray tubes with alternate currents are serious, as the tubes flicker unless the current traverses the induction coil in only one new direction. E. Knoblauch, says *Engineering,* found that even Ruhmer's new interrupter could not be used with an alternate current of 50 periods and 110 volts, probably on account of the voltage being too low. But since it is especially desirable to be able to use low commercial voltages, he used the expedient of introducing an aluminum rectifier in the circuit, consisting of a lead and an aluminum electrode immersed in a twenty per cent Seignette solution. It is thus possible to use Wehnelt, Simon and even mercury-jet interrupters. All of them worked faultlessly after introducing the rectifying cell, and the Rœntgen tube showed a sharp division of the two halves, thus proving that only one phase of the alternate current is transmitted to the interrupter. The electrolytic interrupters all require somewhat strong currents, and thus lead to greater wear of the Rœntgen tubes. Mercury-jet interrupters do not require great current strengths, and the use of the rectifying cell as described is, therefore, specially recommended in their case.

Electric Railways in the English Midlands.

Consul S. C. McFarland writes from Nottingham that the development of electric railways, from an English point of view, has been phenomenally rapid. The Nottingham corporation is just completing the fourth section of its city system, and is applying to Parliament for other extensions, demanded by a public which a year ago scoffed at the general idea, but which has, through the operation of the lines already established, received a quick and practical education.

Although the financial condition of the corporation will not justify further extension, private capital is now proposed to undertake a very large system of suburban and interurban traffic, to be operated in connection with the local systems in the several larger towns involved, and for several of these schemes, which are outlined below, parliamentary powers are being requested for. The two principal plans are promoted by Sir James Kenneth Douglas McKenzie and by Sir Bache Cunard, and the first embraces a large portion of the county of Notts and part of Derbyshire, while the latter relates mainly to establishing a connection of light railways between Nottingham and Derby.

There is further a proposal to carry a line to Arnold; also to Carlton, and eventually to Burton Joyce. By a third proposal, Hucknall Torkard is to be connected with Bulwell. The scheme embraces a distance of about seventy miles, including the section at Mansfield covering twelve miles, which has already been sanctioned; and the total population to be served approaches 500,000.

At present the means of supplying current for the workings of the railways does not exist, but plans have been made to meet this contingency.

Altogether, this proposed linking of city with private enterprise, thus suddenly covering a large territory in the conservative midlands with a network of modern electric lines, is an astounding development for England. The scheme, however, is only the forerunner of what will follow elsewhere in the provinces, as well as in London. The effect of this electrical development upon existing railway lines, whose earnings are already at the maximum and whose dividends are yearly decreasing, will soon present a serious question.

Some Problems in Electric Traction.

A Paper by Dr. C. T. Hutchinson and Its Discussion at the 160th Meeting of the American Institute of Electrical Engineers.

(Concluded.)

From the foregoing equations we have

$$dv/dt = \frac{(a+b)}{100} Y'' - b$$

But

$$dv/dt = \beta [dY'/dt] = \beta [\Delta Y'/\Delta t]$$

and hence

$$\Delta t/\beta = \Delta Y'/[(a+b) Y''/100 - b] \quad (22)$$

From this equation, $\Delta t/\beta$ can be calculated for different values of (a) and (b) by taking from the velocity curve of sheet 5 $\Delta Y'$, and the corresponding values of Y'', the average force ordinate for the interval, $\Delta Y'$. Other methods may be used to calculate this tangent curve.

The values of $\Delta t/\beta$ are calculated and summed up. Plotting these values as abscissæ in terms of velocity as ordinates, a set of curves is obtained for each value of (a) which I call the acceleration or $(v\text{-}t)$ curve of the motor. The input corresponding to each velocity can be plotted on the same sheet, forming a (kw.-time) curve, and from the last by integration, an energy curve. Also from the $(v\text{-}t)$ curve, by integration, a curve of distance and time can be plotted. This gives a set of curves for each value of the initial acceleration, showing at once the power, energy, velocity and distance up to any relative velocity on the motor curve.

The deduction of these curves and their constants is as follows: From (19) and (21) and for W = 2,000 lbs.

$$\text{Power—P} = 0.213 \quad (a+b) \quad \beta \times X \text{ kw./ton} \quad (23)$$

where X is the abscissa, taken from curve sheet 5 for any velocity.

Energy—Similarly,

$$W = \frac{1,000}{3,600} \int_{v=\beta 100}^{v=\beta Y} P\,dt \quad \text{wh./ton}$$

and substituting from (23)

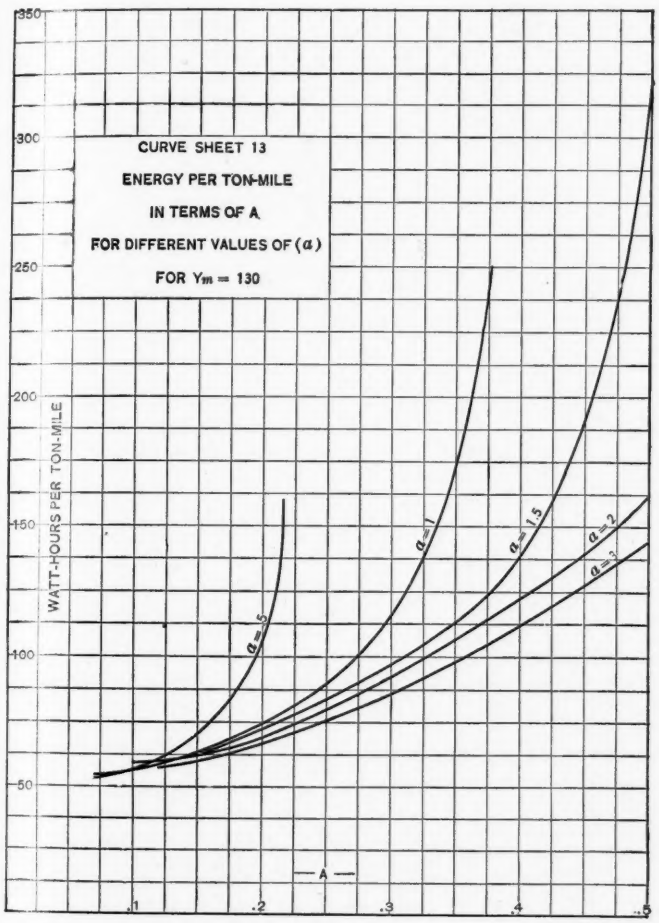
$$W = 5.92 \times 10^{-2} (a+b) \int_{100}^{Y} Y\,dX \quad \text{wh./ton} \quad (24)$$

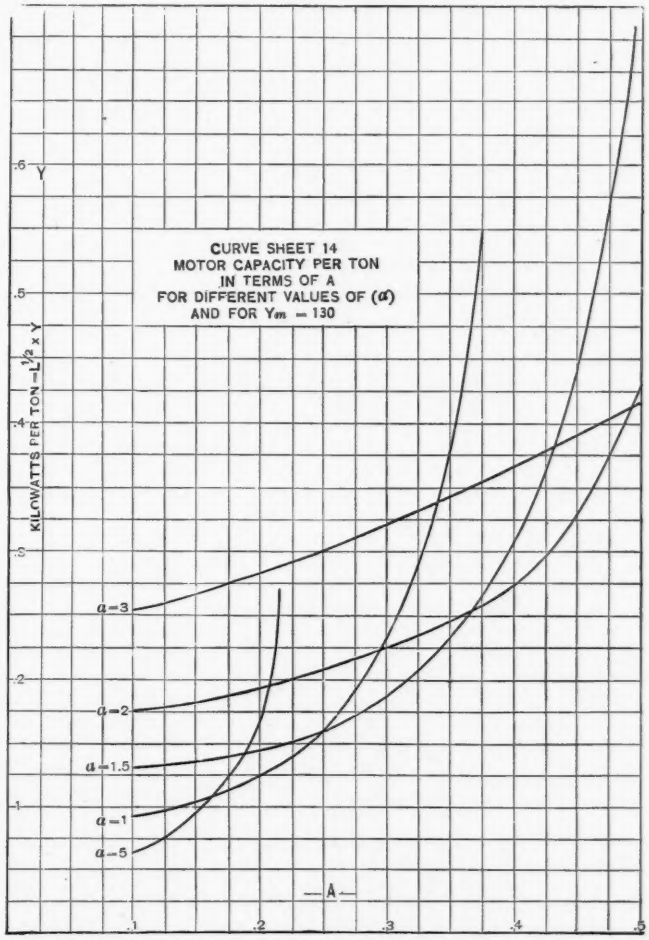
Y and X are the coordinates of P on the several accelerating sheets.

Distance—

$$S = 1.467 \int v\,dt = 1.467\,\beta^2 \int_{100}^{Y} Y\,dX \quad (25)$$

where Y and X are the coordinates of (v) on the several acceleration sheets.





Curve sheet 6 is calculated and plotted from equations 22, 23, 24 and 25, for $(a) = 3$. It shows velocity, distance, power and energy per ton in terms of time; the curves will start at $v = \beta 100$; that is, the energy and distance are for the motor curves, and do not include energy and distance up to velocity $v = \beta 100$.

Curve sheets 7, 8 and 9 give the same quantities for $(a) = 2$, 1, and 0.5 respectively.

The coefficient a has disappeared from these curves, only β the velocity coefficient remains. Power and velocity are proportional to β; energy and distance to β^2.

As an example of the use of these curves, take $a = 3$, curve sheet 8. For a motor to have a rated velocity of 20 mph.,

$\beta = 0.2$; after a time $X = 70$ $\beta = 14$ seconds, the velocity will be $159\ \beta = 31.8$ mph.; the power $21.0 + \beta = 4.20$ kw.; the energy used on the motor curve,—$590\ \beta^2 = 23.6$ wh., and the distance traversed on the motor curve, $14{,}250 \times \beta^2 = 570$ feet.

From these (v-t) curves, Fig. 4 is drawn, on which the line OM represents the initial acceleration continued to the velocity $v = \beta\ 100$, where the acceleration on the motor curve begins and continues to any point N; the velocity RN is made anything within practical conditions; coasting begins at N and continues to B, where brakes are applied. The ordinates multiplied by β give the velocity, the abscissæ multiplied by β give the time; hence the inclination of any line on this diagram is independent of β.

Correction to Type Curve—This discussion and the curve sheets deduced from it, determine all the elements of the type curve, OABC. This type curve bears a certain relation to the motor curve OMNBC. The distance traversed in the first case will be greater than in the second by the equivalent of the area MAN. It is then possible to reduce each case for the motor curve to a corresponding case for the type curve, by applying a correction, calculated in the following manner:

Determine the area MAN of Fig. 4 for each (a), and for any desired number of points on the motor curve; call this area Δ; then $1.47\ \beta^2\ \Delta$ is the distance in feet represented by the area.

Let

Y_t be the maximum velocity AD on the type curve;

Y_m be the maximum velocity RN on the motor curve.

A be the through acceleration on the type curve;

A_m be the through acceleration on the motor curve;

and

X be OC

Then

$$L = L' - 1.47\ \beta\ \Delta$$
$$\beta^2\ A_m X^2 = \beta^2\ A X^2 - \beta^2\ \Delta$$

or

$$A_m = A - \Delta/X^2$$

Put

$$\lambda = a\ x/T = Y_t/X \qquad (26)$$

then

$$A_m = A - \Delta\ (\lambda/Y_t)^2 \qquad (27)$$

Y_t is found from curve sheets 6, et seq., and λ from curve sheet 2, for any values of A (a) and Y_m; A_m is then calculated, and plotted in terms of A, using the values of Δ previously calculated.

The values of A_m for all values of A, Y_m and (a), have been determined in this way; the corrections for values of Y_m less than 130 are too small to be taken into account. As I shall show, the minimum energy required for all schedules and for all values of (a) is practically at $Y_m = 130$; in some cases, greater values of Y_m give slightly less energy, but the difference is so trifling that I have used only this value in discussing the energy relations.

Curve sheet 10 shows A_m in terms of A, for $Y_m = 130$, and for the different values of (a).

Maximum A_m—The maximum A_m is evidently attained when acceleration is continued to the braking point, and is represented by OMNC′ (Fig. 4). To calculate this maximum, OR is found from curve sheet 6 et seq.; RC′ from the known values of RN and (c); then $RC'/OC' = z/T$.

Curve sheet 2 gives at once the values of A, and curve sheet 10, the corresponding A_m. The values so calculated for $Y_m = 130$ only are given on curve sheet 11.

An example best shows the use of these curves:

Suppose

Schedule speed = 16.5 mph.
Distance between stops = 2,090 feet.
Time of stop = 15 secs.

Then,

Total time from start to start = 82.4 secs.
Running time = 67.4 secs.
Average velocity, V = 20.2 mph.

$$A = V/T = 0.3.$$

Curve sheet 11 shows that (a) must be greater than 0.75; take $a = 1$; then curve sheet 8 determines the velocity curve up to the point N (Fig. 4); for $Y_m = 130$; curve sheet 10 gives A = 0.305, and from curve sheet 2,

$$x/T = 0.477$$
$$y/T = 0.130$$
$$z/T = 0.393$$

Maximum velocity on type curve = $0.477 \times 67.4 = 32.3$ mph. Maximum velocity on motor curve = $32.2 \times 130/136 = 30.7$ mph. Velocity at braking = $3 \times 0.130 \times 67.4 = 26.3$ mph.

Energy Input—The energy at the car axle has already been determined; the electric input depends upon the method of motor control and the efficiency of the motor. I assume that series-parallel control in two steps is used. The power at the axle at rated velocity, that is, point M, is then $0.85\ P_0$, where P_0 is the rated power, and the power at the axle is proportional to the speed. The change from series to parallel is assumed to occur at half speed; the efficiency of the motors will be about 70 per cent when in series and carrying rated current. With these figures the input up to $v = \beta\ 100$ is

$$W_0 = 0.08\ P_0\ t_1 \qquad (28)$$

and the output is

$$W' = 0.425\ P_0\ t_1,$$

hence the efficiency up to rated velocity—while resistance is in circuit—is 53 per cent.

Substituting for P_0 its value from equation (23), and $t_1 = 100/\beta$, the input of electric energy per ton up to the point M is

$$W_0 = 475\ (1 + b/a)\ \beta^2 \qquad (29)$$

The values calculated from this equation are included on curve sheets 6, 7, 8 and 9, giving the energy up to the point $v = \beta\ 100$. The input from the point M to the point N on the motor curve, is taken directly from curve sheets 6 et seq. depending upon the initial acceleration.

Velocity Constant β—Energy, power and distance all involve the velocity constant β. The values of β can be expressed in terms of the distance traversed, for all values of the through acceleration, as follows:

$$0.682\ L = AT^2$$
$$T = \beta\ X$$

and

$$X = Y_t/\lambda;$$

hence

$$\beta = \left(\frac{0.682\ L}{A}\right)^{1/2} \times (\lambda/Y_t)$$
$$= \left(\frac{0.682\ L}{A}\right)^{1/2} \frac{a}{Y_t}\ \frac{x}{T} \qquad (30)$$

The energy used is proportional to the product of β^2 by the ordinates of the energy curves on sheets 6 et seq. There will, therefore, be a different multiplier for each value of (a) and of Y_m.

Limiting the discussion to $Y_m = 100$ and $Y_m = 130$, the following table gives the values of the energy per ton in terms of β.

TABLE I.

Energy up to $v = \beta\ 100$ and $v = \beta\ 130$.

(a)	$v = \beta\ 100$	$v = \beta\ 130$
0.5	$665\ \beta^2$	$1115\ \beta^2$
1	570 "	865 "
1.5	535 "	800 "
2	522 "	767 "
3	507 "	732 "

From equation 30, β can be calculated for all values of A and (a), and for all values of Y_m. The simplest way to calculate these values is, first to assume values of A and (a): then since $Y_m = 130\ Y_t$ is fixed; the value of x/T is taken from curve sheet 2.

β is proportional to $L^{1/2}$; β^2 to L; hence the energy used is proportional to the distance for any given value of A. The values of β have been calculated from this equation for all values of Y_m; I give here, however, a curve sheet showing these values only for $Y_m = 130$, for the reason explained below.

This sheet covers the entire range of values of β for $Y_m = 130$ from the minimum to A = 0.5; this value of A is greater than is possible in practice.

The energy for all schedules can now be calculated by multiplying β^2 from curve sheet 12 by the constants given in table 1. The values so calculated for $Y_m = 130$ are plotted on curve sheet 13.

I have calculated the energy consumption in this manner for all values of Y_m and for the different values of (a) and of A, up to $Y_m = 160$. To give all these results is of no value, since the result shows that in nearly all practical cases the energy input is substantially a minimum for $Y_m = 130$. Table 2 below shows the relative energy for different values of Y_m for (a) = 2, in terms of energy for $Y_m = 130$, as 100 per cent, for the various values of A.

TABLE II.

Relative Energy for Different Use of Motor Curves for (a) = 2, in Terms of Energy for $Y_m = 140$ as 100 per cent.

Y_m	A				
	.5	.4	.3	.2	.1
160	...	102%	91%	91%	89%
150	104%	101.5	98	93	93
140	100	100	99	95.5	95
130	100	100	100	100	100
120	103.5	106.5	106.5	105.5	105
110	110	112.5	113	112	108
100	119	122	121	128	120

This table is a fair example; it shows that the difference between the energy for 130 and greater values of Y_m is comparatively small. In the rest of this discussion, I use this value of Y_m only, and the values of β are for this reason given only for $Y_m = 130$.

Curve sheet 13 gives at once the answer to all questions regarding the energy required for any schedule; it shows clearly how slight is the saving in energy effected by the use of rapid accelerations. For instance, for A = 0.25, the energy for an acceleration of one mile per hour per second is 17.2 wh.; for an acceleration of 3 mph./sec, it is 14.5 wh.; that is, increasing the acceleration in the ratio of three to one diminishes the energy required only 16 per cent.

Motor Capacity—This discussion has been based throughout on the assumption that the motor operates at the rated capacity on the one-hour basis, when at the point M (Fig. 4). On this assumption, the following table gives the capacity of the equipment required.

(a)	$P_0 = \beta \times$
0.5	14.9 kw./ton
1	25.5 "
1.5	36.3 "
2	47 "
3	68 "

These are the starting values of the power curves on sheets 6, 7, 8 and 9, and may be considered the rated capacity of motors required, in so far as this rating is determined by commutation. Taking into account grades and curves and the possibility of various emergency requirements, I think it conservative to say that a motor should not be designed to operate above its one-hour capacity under the conditions here assumed, that is, on straight, level track, with frequent stops. The capacity of the motor depends also upon heating, and in most cases this is a ruling consideration. Hence it becomes necessary to determine the amount of heat liberated in the motor under all conditions of initial and through acceleration.

Heat Losses—Referring to Fig. 4, the heat losses in the copper up to the point M are directly proportional to the time, since heat is liberated at a constant rate. The magnetic flux density in the motor is constant up to this point; if the core loss were proportional to the speed, the average loss would be one-half of the loss at rated speed; on the other hand, if the core loss were proportional to the square of the speed, the average loss would be one-third of the loss at rated speed; hence the average core loss up to the point OM is between 33 and 50 per cent of this loss at rated speed. The actual variation of the core loss with speed lies between these two values; I assume it to be equal to 41 per cent of the loss at rated speed. It is of comparatively little consequence whether it be taken at 33 or 50 per cent, or at any intermediate value, since the core loss at rated speed is less than 30 per cent of the total heat loss at rated speed; considerable errors in its values are of little moment.

I find from an examination of a number of modern tramway motors that at rated output P_0 the average core loss is 3.4 per cent, and the average copper loss 8.6 per cent—a total for the average loss of 12 per cent, excluding friction losses. These losses are the average of a somewhat different group of motors from those used in preparing the general motor curve, hence the small loss left for friction; for this last group the efficiency is 83 per cent instead of 85 per cent. The variations of the separate losses in the different motors are, generally speaking, small, although in certain motors the disparity is greater. The average loss up to $v = \beta\ 100$ is then 10 per cent of the rated capacity, and is independent of initial acceleration.

From M to N on the motor curve, I have determined the losses from curves of separate losses; for the same group of motors the average of the total heat loss from $v = \beta\ 100$ to $v = \beta\ 130$ is 8.5 per cent of the rated capacity.

Up to $v = \beta\ 100$, the average loss is 10 per cent of P_0; for $v = \beta 130$, the values of t_1 and t_2 are taken from sheets 6, 7, 8 and 9, and the average loss over the total time $(t_1 + t_2)$ calculated; it will be found to be constant for all values of (a), as it should be, and equal to 9.4 per cent of rated capacity.

The average rate of heat dissipation will be:

$$0.1\ P_0, \quad \text{up to } v = \beta\ 100$$
$$\text{and } 0.094\ P'_0, \quad \text{up to } v = \beta\ 130.$$

The rates continue for the times t_1 and $(t_1 + t_2)$, respectively; during the rest of the cycle the motors are radiating heat; hence these rates referred to the total time T, are

$$0.1\ t_1/T \times P_0, \text{ up to } v = \beta\ 100,$$
$$0.094\ (t_1 + t_2)/T \times R'_0, \text{ up to } v = \beta\ 130,$$

and as percentages of the rated capacities in the two cases are

$$10\ t_1/T\% \quad \text{up to } v = \beta\ 100. \quad (31)$$
$$9.4 \times (t_1 + t_2)/T\% \text{ up to } v = \beta\ 130. \quad (32)$$

These are the average rates for the entire time from start to stop, and by comparison with the average loss that such a motor will stand continuously without excessive heating, determine whether the motors would be running above or below their rated capacity; or conversely, determine what the capacity on a one-hour basis must be, so that when operating in this way they will not overheat.

Equation (32) can be written

$$9.4\ (1 + t_2/t_1)\ t_1/T\%$$

But (Fig. 4)

$$t_1 = \overline{OP} = OD.\ MP/AD$$
$$= x \times 100/Y_t$$
$$\text{and } t_1/T = x/T\ (100/Y_t)$$

hence the total heat loss up to the velocity β 130 averaged over the entire time T is

$$9.4\ (1 + t_2/t_1) \times 100/Y_t \times x/T\% \quad (33)$$

where x/T is taken from curve sheet 2 for the proper values of A and (a). In this deduction it is assumed that $A_m = A$.

Hour Rating—The one-hour rating of a tramway motor is much in excess of the continuous capacity; approximately such a motor will carry its rated output for 25 per cent of the total time, that is, for one minute out of four; the heat generated at rated capacity for one-quarter of a complete cycle will bring it to its rated temperature. It is assumed that the cycles are repeated at such intervals that a permanent régime is attained. This is only an approximation, but is a fair one, if the percentage be more or less than 25, and the conclusions can be altered to accord.

As the average heat losses at rated load are 12 per cent, it follows that such a motor can dissipate continuously 3 per cent of its rated capacity; when the average rate is over 3 per cent the motor is overloaded.

Since the average loss that a motor will stand is equal to 3 per cent, it follows that the maximum value of (x/T), or $(x/T)_0$ is

$$(x/T)_0 = 3/[9.4\ (1 + t_2/t_1)] \times Y_t/100$$

Curve sheets 6, 7, 8 and 9 give then

TABLE IV.

(a)	$(x/T)_0$
0.5	0.249
1	0.260
1.5	0.265
2	0.278
3	0.271

For $Y_t = 100$, the limiting value is $(x/T)_0 = 0.3$ for all values of A and (a).

This means that for schedules in which $x/T > 0.3$, in one case, and for $x/T > 0.249$ et seq. in the other, the capacity must be greater than the capacity determined by commutation, that is, greater than the values of table 3 in the ratio of $(x/T)/(x/T)_0$; for $x/T < 0.3$, or less than the values of table 4, commutation determines the capacity.

The motor capacity necessary both to avoid overheating and to keep within commutation limits, can now be calculated from these data. Table 3 gives the capacity required on the assumption that commutation is the only limit to output, and on the further assumption that the hourly rated capacity is the practical limit determined by commutation. These values multiplied by the ratio $(x/T)/(x/T)_0$ give the capacity in all cases, with the limitation that the capacity shall not be less than that of table 3. Then,

$$\text{Motor capacity} = 14.9\ \beta \times (x/T)/(x/T)_0 \quad \text{for } a = 0.5 \quad (34)$$

and motor capacity $> 14.9\ \beta$ for $a = 0.5$.

The coefficient for other values of the initial acceleration is given by table 4.

The capacity of the motor, as determined by this equation, has been calculated for all values of A and (a), and curve sheet 14 gives the kilowatts per ton, considering both commutation and heating, for $Y_m = 130$.

For the lowest acceleration, $(a) = 0.5$, heating is the limitation for all values of A; for the higher values of (a), commutation is the limitation for the low, and heating for the high, values of A.

I wish to emphasize the conditions under which these capacity curves were obtained; (1) that the limit of input determined by commutation is the rated capacity, and (2) that the limit determined by heating is an input that will average for the total time 3 per cent of rated capacity in copper and core losses. I am aware that motors are operated at much greater inputs than the rated capacity in regular service, but for service requiring frequent stops this is not unduly

low, if low-maintenance cost is taken into account. It is easy to follow out this argument with any desired overload at starting; the results will be but slightly affected.

Similarly, with reference to heating, 3 per cent is not a sacred figure, but only a fair average; it is easy to make the changes for any other value. No changes within practical limitations will affect the relative results for different schedules and initial accelerations; the absolute values only will be slightly changed.

As this entire discussion has been based on the assumption that the input of the motor along the line OM of Fig. 4 (that is, during the period of constant acceleration) is its rated capacity, it would seem at first glance that the increase of capacity necessitated by heating conditions would vitiate all the deductions given here. This, however, is not the case. The velocities are in no way affected; hence the energy at the car axle is unaltered. The only change brought about by using a motor that does not operate at its rated capacity during the initial period, is a change in the heat losses in the motor. This will not affect the energy input greatly, since almost the entire losses during this period are losses in external resistance; hence the curves showing energy required per ton mile will be substantially unaltered. Such change will in all cases increase the heat waste in the motor, hence the capacity, given on curve sheets 16 and 17, will in all cases be somewhat too small. On the other hand, the capacity so calculated is greater than necessary, as no allowance has been made for heat radiation during the time of stop at stations.

Another consideration leads to the same result. As I have shown, the energy used per ton mile varies very slightly for any amount of acceleration on the motor curve from 120 per cent to 160 per cent. To use a motor, at other than the rated capacity, means that the motor is operating on a different part of the motor curve; hence, the difference in energy input will be small.

Weight of Equipment—These curve sheets show that the motor capacity for high initial accelerations is generally greatly in excess of the motor capacity required for low initial accelerations. Greater capacity of equipment necessarily means greater weight of equipment, not only in the motors themselves, but also in the trucks, controllers, and other parts. This entails the further necessity of more energy to carry this greater weight; each addition of weight means a further addition to the energy necessary. To get a correct comparison of the total energy per mile required for different initial accelerations, the values of curve sheet 13 should be multiplied by the ratio of the necessary weights in the two cases. For instance, for an initial acceleration of 3 mph./sec, the total weight of equipment may be 25 per cent greater than for an initial acceleration of 1 M. P. H./sec; the total energy used per mile will then be increased in the ratio of increase of the weights.

I have taken the weights of all parts of a car equipment in detail for different capacity of motors, varying from 30 to 150 rated horse-power, for both two and four-motor equipments. These weights include motors, controllers, trolley poles, car wiring, motor trucks, trail trucks, and car body. I have deduced from these weights curve sheet 15, on which the ordinates show the ratio of weights for different capacity of equipment, in terms of kw./ton of total weight as abscissæ. For instance, for an equipment of 4 kw./ton of total weight, the ratio is 1.44; for an equipment of 8 kw./ton, the ratio is 1.93; the increase of equipment from 4 to 8 kw./ton then increases the total weight in the ratio of $1.93/1.44 = 1.34$; that is, doubling the equipment means an increase of 34 per cent in total weight; hence, 34 per cent in total energy used. The ordinates of curve sheet 13, giving energy per ton mile, multiplied by the ratios from curve sheet 15 for the different capacity of equipments, determined by curve sheet 14, will be proportional to the total energy required per mile.

The capacity of the equipment is proportional to $L^{\frac{1}{2}}$, and as the distance will vary in each case, it is not possible to deduce any general results; each case must be considered by itself, in this particular. I have made these calculations for a number of cases to correspond with practical conditions; the result is always that the energy used per mile is less for the lower accelerations. As an example, let

$$V = 16.5 \text{ mph.}$$
$$L = 2{,}000 \text{ feet;}$$

then

$$A = 0.2.$$

From the various curve sheets, the following table is deduced:

TABLE V.

a	kw./ton.	wh./ton.	ρ	$\rho \times$ wh./ton.	
				wh.	%
0.5	7.6	106	1.87	198	174
1.0	5.6	75	1.63	114	100
1.5	6.5	73	1.73	126	111
2.0	8.7	70	2.03	142	124
3.0	12.6	67	2.65	177	156

The last column of this table shows the energy required per mile to be the minimum for an acceleration of 1 mph./sec.; the motor capacity is also at a minimum for this acceleration.

To take the case of the proposed express service of the New York rapid transit line: Here the schedule speed will be 35 mph.; the average distance between stations, about 7,500 feet; time of stop at stations, 15 seconds.

From these data,

$$V = 38.8 \text{ mph.}$$
$$\text{and } A = 0.275.$$

The following table is deduced from these data:

TABLE VI.

a	kw./ton.	wh./ton.
1	16.7	102
1.5	14.9	82
2	18.8	72
3	26.9	62

This table shows the practical impossibility of accomplishing such a schedule on the assumptions of this discussion. The minimum motor capacity required of 14.9 kw./ton, is beyond the range of practical conditions. The weight of motors, controllers and wiring, that is, the electrical equipment alone, will be about 75 pounds per kilowatt, and the weight for 14.9 kilowatts would be about 1,140 pounds. This does not leave sufficient weight for the other parts of the equipment. For an acceleration of 3 mph./sec, the weight of the motors required 26.9 kilowatts would be approximately one ton, that is to say, at this initial acceleration the motors would just be able to propel themselves.

Conclusions—My conclusion from this discussion is that the acceleration that gives the lowest motor capacity per ton is in all practical cases the most economical. The very small saving in energy is not to be compared with the many disadvantages of very rapid initial accelerations. Assume, for instance, a gain of 10 watt-hours per ton mile for an acceleration of 3, over that required for an acceleration of one; for a 20-ton car, and with energy at 0.5 cent per kilowatt-hour, this represents a saving of 0.1 cent per car-mile. This is too trifling to be considered in comparison with the fixed charges on the greater investment for motors and distribution system; the poorer load factor at the power station, the increased cost of maintenance, the difficulty of accurate handling of cars, and, above all, the much greater discomfort to passengers.

Although I have to make, in the course of this discussion, various more or less arbitrary assumptions, I believe that they are all fair ones, representing average conditions. It is open to any one to follow this method on such other assumptions as may suit his fancy. I believe, however, that no practical assumptions will change the general results.

Upon the conclusion of Dr. Hutchinson's paper, Mr. S. T. Dodd took up some of the points raised in Dr. Hutchinson's paper, and by assuming a given practical case managed to attain results opposed to those exhibited by Dr. Hutchinson. Mr. Dodd was followed by Mr. Norman W. Storer, who read a short paper on the "Importance of the Inertia of the Rotating Parts of a Train"—that is, car-wheels and armatures.

A paper by Mr. E. B. Potter, bearing upon the same subject and taking issue in some degree with Dr. Hutchinson, was read in the absence of its author by Mr. Calvin W. Rice.

Mr. W. C. Gottshall took issue with Dr. Hutchinson, and stated that his paper covered a case which did not exist in practice, and drew conclusions which were opposed to observed results.

In the absence of the author, Dr. Samuel Sheldon read a paper by Mr. M. H. Gerry, Jr., also taking issue with Dr. Hutchinson. At the conclusion of this paper Dr. Hutchinson replied briefly to the remarks made in the discussion.

THE CONSTRUCTION OF SMALL TELEPHONE EXCHANGES—XXV.

BY A. E. DOBBS.

STEP BY STEP SYSTEMS.

Another and more practical scheme of selective signaling is by the step-wheel process which was also exploited years ago but now again seems to be coming into favor among inventors, and although all fundamental patents have expired some detail patents are still being taken out and the problem seems to be so nearly approaching a solution that we may look for quite an extensive adoption of some method of step-wheel signaling in the near future.

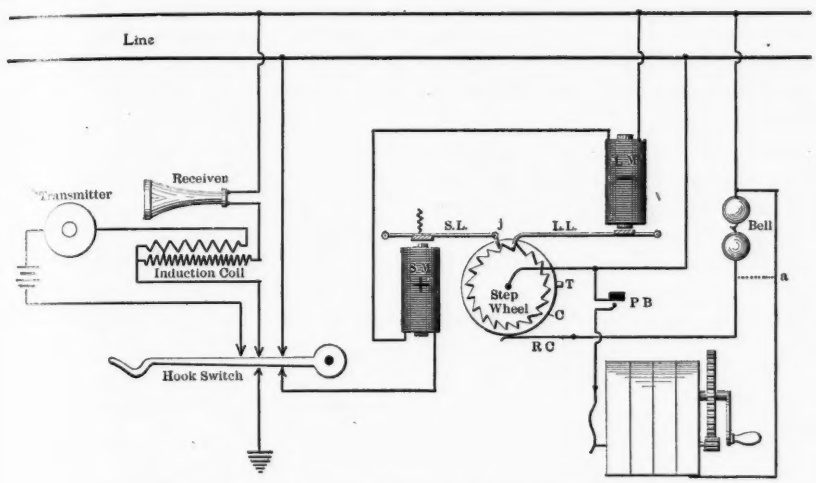


FIG. 105.—A STEP-WHEEL SYSTEM OF SELECTIVE SIGNALING.

With the idea of contributing his mite to the fund of information on the subject the writer submits a sketch which represents, in a general way, his idea of what such a system should be.

In the making of this sketch there is no pretense to originality, and suggestions were borrowed from both the Drake and Mayberry systems, and it is possible that some parts of it are covered by patents.

The sketch is shown in Fig. 105.

First, we have two polarized magnets in series with each other, but bridged to one side of the line, SM, LM, and a toothed wheel which may be stepped forward to any point desired. This toothed wheel is fixed on a shaft with another and larger wheel, C, which has a smooth surface, except for the platinum tip, T, which projects outward and which is intended to make contact with the tip brush, RC, as it is revolved around, thus putting the bell in circuit, which, up to this time, has remained open. With the tip, T, in contact with the brush, RC, the bell can then be rung from the exchange over the metallic circuit in the usual way.

The magnet, SM, is a stepping magnet, and every impulse sent over the line sets the wheel one notch ahead by means of the lever, SL, hinged at the point, *j*. When the lever, SL, is lifted, the wheel is held in place by means of the second lever, LL. It is, of course, supposed that the wheel as it is stepped forward winds up a spring which has a constant tendency to make it fly back to the home position. As explained before, the two magnets, SM, LM, are polarized so that when + or — impulses are sent to line only one will act at a time.

In this case we will suppose that only positive impulses are sent over the line by means of a battery or continuous-current generator.

In making these impulses the operator may move a dial hand over, let us say, six contacts which makes six impulses and steps the wheel six points ahead by means of the magnet, SM, and the lever, SL.

The points, T and RC, are now in contact, putting the bell in circuit, upon which the operator signals by means of an alternating or impulse current as usual. As this tip, T, is placed differently in each instrument it will be seen that there is but one bell in circuit, all the rest being open, and that but one bell will ring which will be the one wanted.

After the operator rings the bell it now becomes necessary to restore the step-wheels to their normal position again. This is done by sending a — current to line which operates the lifting lever, LL, thus allowing the wheel to be drawn back by its spring.

The two magnets, SM, LM, may be of 500 ohms each, which will not seriously ground the line. When the subscriber lifts his receiver from the hook this ground is cut off at his own instrument, though still remaining grounded at all the others through the selector magnets.

When the subscriber wishes to signal the exchange he can do so by means of an open-contact generator, or by pressing a push-button, PB, and ringing in the usual manner.

The generator circuit may be made tc include the bell, though it is not necessary that a subscriber should hear his own bell ring. To include the bell connect at the dotted line *a*.

One subscriber can not call any other subscriber, although that could be arranged by leaving battery continuously on the line; but it is better that the operator should do all the ringing, as in this way it is easy to keep account of the business done.

In calling the subscriber, therefore, the operator may use either a lever with an indicator pointer attached, which makes and breaks circuit the required number of times, or may push a button to make the necessary number of impulses.

Second, she rings the subscriber.

Third, she throws a lever over, sending a — current to line which sets all the stepping wheels back again. All this need not take more than four seconds, and the possible number of different signals that can be sent is only limited by the number of teeth on the wheel and the amount of current available; but from six to ten should be the limit rigidly adhered to.

Now there might be defects in this system that do not show up in the sketch just presented, and different inventors might arrange the circuits somewhat differently. One would use a third wire and use low-resistance magnets (SM, LM) in series, thinking in this way to get a quicker, sharper action, and it is a fact that high-resistance magnets are apt to be sluggish, but it is a fact that in telegraph relays several high-resistance magnets in series will transmit signals as fast as the average operator cares to send, and low-wound magnets require more current.

Some might prefer to make the ground tap between the two magnets instead of sending the current through both in series. Then there are several different ways of moving a step-wheel, but, as said before, the sketch is submitted to give our readers an idea of what such systems may be like and what they may expect soon.

As to the amount of current required, a continuous-current generator delivering a current of 0.25 of an ampere at 100 volts should run twenty stations provided the line resistance does not exceed 1,000 ohms.

This instrument is not much more complicated than the average magneto generator.

It is not advisable to place more than ten stations on one line for the reason that more than one subscriber will often want to use it at the same time. Farmers, especially, often have plenty of time to talk, and a case is on record of one agriculturalist holding the line for one hour and ten minutes talking a horse trade or something of the sort, while a half a dozen calls for other parties on the line were kept waiting. Thirty minutes among this class of patrons is by no means uncommon. At the same time to increase the number of circuits requires an extra outlay for wire, pins, insulators, and sometimes cross-arms, and a trouble account that increases with the number of wires.

Thus in one circuit there are three general classes of trouble—broken wires, grounds and crosses; with two circuits our number is increased to seven—broken wires, grounds and crosses multiplied by two, with the additional chance of their getting crossed with each other; with three circuits our trouble chances have increased to eleven; with four circuits, to fifteen and so on. These chances may be greatly minimized by proper construction, but the proportion holds good nevertheless.

Therefore, as long as farmers demand cheap service they should put up with what you can furnish them.

If there was some way of metering telephone service by automatically registering the number of minutes each month that the telephone is in use long-winded conversations would be cut down. This might tend, however, to discourage the use of the telephone which is not desirable at the present time.

TOLL LINE SERVICE.

One common mistake in running local toll lines consists in putting too many stations on one line. A busy man who comes to a toll station and has to wait half an hour for a connection becomes disgusted, and if the programme is repeated half a dozen times he will come to look upon long-distance telephoning as a painful duty to be shirked whenever possible. If there chances to be a telegraph office or a rival telephone company anywhere in the neighborhood he will give them the preference if they can possibly give him the service he desires.

As a horrible example, the writer once saw a toll line eighty-five miles long—a metallic circuit transposed every half mile—built of No. 14 iron wire loaded down with twenty-two stations. Though generally possible to signal all the stations which were bridged to the line, yet the numerous signals were so confusing that long delay in answering was the result, to say nothing of others, not called, who either mistook the signals or listened in anyhow to such an extent that good talking service was out of the question. With this condition of things, those in charge of the stations became careless or indifferent to toll collections, and still more careless in settling accounts.

Repairs to the line were consequently neglected, and it soon went out of service altogether and farmers appropriated the wire to repair their fences. It is to be hoped that not many toll lines are as bad as this one was, but there are some not much better and of all annoyances they are the worst, for when a man wants to use a telephone he is often put to a great deal of inconvenience and loss by his dependence on service he doesn't obtain at the time.

Fig. 106 was the plan the writer was called upon to make as a remedy for this state of affairs, and before entering into a detailed explanation of it we will first discuss the conditions.

There were two towns 135 miles apart desiring connection with each other, both of which had exchanges of about 500 subscribers.

Between the two exchanges there were about twenty small villages, not one of which possessed an exchange, nor were they likely to do so until toll lines could be built.

Most of these villages possessed only one or two general stores in which it was necessary to locate the telephone stations, which would have to be attended to by the proprietor or his clerks.

It was necessary to have the instruments so wired that stations could not call each other, as all connections were to be charged and no pay-station device would meet the case. They must therefore call regularly authorized agents at certain designated places who would keep an account of all service connections.

Owing to the fact that the proprietor or his clerks would not be likely to notice a drop fall, all signaling was to be done by means of extension bells placed on each line.

It was decided to place two agents between the North and South exchanges, at distances of forty-six and forty-two miles, respectively, from the first exchange, thus dividing the through line, as nearly as possible, into three equal parts.

It was decided to run two circuits—one of No. 12 aluminum wire for through business, and the other of No. 12 B B iron to take care of the local service. This would give the through line a resistance of about 6,000 ohms, while on the local line no subscriber would have to ring through more than about 1,000 ohms to get his calling station, though, as arranged, he might be talking over 5,000 ohms with the hook up. Larger wire would have been better, but there were financial considerations.

Turning now to Fig. 106, we find the through line looped into calling stations A and B, so that it is possible to divide the line for testing or business purposes and carry on three through-line conversations at one time.

The through line, it will be observed, is connected to the station jacks in the same manner as previously described in Figs. 93 and 94.

Beginning at the northern end, there are no stations for about fifteen miles, while the business from there to station A would probably be light, for which reason a single grounded line took care of local business. There were six telephones on this section. All the ringers on this section were to be wound to 1,600 ohms, while the extension bell at the station (A) was wound to about 100 ohms, which gave it the advantage over the others in signaling. Thus, when a subscriber would ring in, the bells near him might respond feebly and the others not at all, but the low-resistance station bell would ring loudly, thus attracting the attention of the agent who, having a percentage interest in all payments for calls, would naturally watch out for special signals if they were attempted. South of station A the line was metallic circuit and here again some ingenuity had to be exercised to prevent surreptitious signaling. This was accomplished again by means of a 500-ohm extension bell connected to ring to ground the jack and one side of the line.

The subscribers' generator, shown in the lower right-hand corner, was of the ordinary series pattern, the generator being a small three-magnet 10,000-ohm type which would hardly ring three bells in multiple. The wiring of the box was precisely like that of a series instrument, except that the ringer was wound to 1,000 ohms, while from the base of the switch hook a wire ran through an open push-button, PB, to ground.

In order to ring the station the subscriber would push the button, PB, and ring the station through the ground, his own bell ringing but feebly. Should he neglect to push the button his own bell would ring, but his generator, not being built for multiple work, would not ring

the others loud enough to attract any attention, which would have a discouraging effect. In ringing the subscribers the stations (AB) would ring out on the metallic circuit, the ground being then cut off by the insertion of a plug.

The grounded line and metallic circuit can be connected together by a cord, in the circuit of which is a repeating coil to separate the circuits from each other. There is also another pair of cords for connecting the metallic circuits together, bridged across which is a 1,000-ohm extension bell used as a clearing-out signal. This pair of cords is not equipped with a repeating coil, but connects straight through and is used for connecting the metallic circuit to the through line.

Station B is similar to station A except that, having no grounded lines, there are no repeating coils in the cord circuit. By connecting the local lines together connections can be made for about 100 miles, the southern end of the local line stopping about ten miles short of the southern exchange.

There are also three other places, not shown, where all lines are looped in for testing purposes; between A and the north end; between A and B, and between B and the south end, which makes test stations from twenty to twenty-five miles apart. There is no means of plugging in on the main line however at these extra stations, except by unlocking a box, and they are only used when locating trouble and upon request. They are equipped with switches, as shown in Figs. 91 and 92, which are locked in a box and a key left with the subscriber. Thus in case of trouble on one section of the line the knife-switches could be opened on one side or the other and the balance of the section cleared. This, between the north end and A, would allow the subscribers to ring each other in case they could not get A. As the lines between A and B run into both stations, it was thus possible to cut the defective end out of one station and allow the other to be used.

Transpositions were made every half mile on the main line and three-fourths of a mile on the local metallic circuits. The station telephones at A and B were fitted with a flexible cord and plug by which connection could be made to either end of any one of the lines. When this plug was inserted in one of the main line jacks, one side was cut out, but the extension bell was still connected to the unused end so that the station could still be called on that end of the main line. As fully fifty per cent of the calls were to and from the city exchanges the plan of a divided line was of considerable importance.

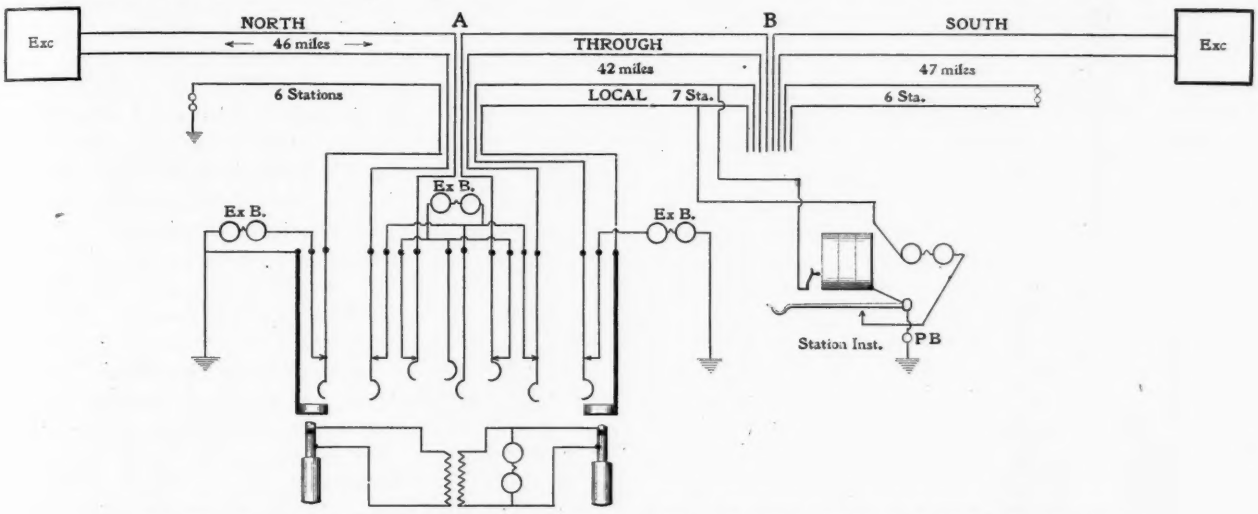


FIG. 106.—TOLL LINES WITH CONNECTIONS FOR COUNTRY STORE SERVICE. THROUGH LINE 135 MILES LONG.

These stations, AB, were connected together in their local lines, and subscribers could signal either end according to whether the message was to go north or south. In case of trouble in the middle section of the main line the message could be transferred around the trouble over the local line, AB, No. 12 wire and seven stations being no bar to good talking service.

In running the lines the single iron wire north of A was placed on a bracket below the aluminum circuit and was depended upon to stiffen the pole line, as, owing to the lightness of No. 12 aluminum (thirty-two pounds per mile), it did not take much of a strain to "pull it up level," which more than compensated for its somewhat low tensile strength. As it was in a southern country, where there was no trouble from snow or sleet storms, the only trouble was from falling trees which would break steel wire as well as the other.

There might be some criticism of this plan, as there are always two or three different methods of attaining a given object.

It might be asked, why the generators at the subscribers' stations were not equipped with a commutator similar to some of those shown in Figs. 101, 102 or 103, and the controlling station signaled by means of a polarized bell which could also have been permanently bridged across the line and used as a clearing out signal, thus avoiding the necessity of an extra bell in the cord circuit?

To this it may be answered that the company had quite a number of telephones on hand which were very good instruments, and they did not wish to buy any more unless it was really essential that they should do so. Furthermore, a series instrument fitted with a 1,000-ohm ringer was considerably cheaper than if fitted with a commutated generator and, as before remarked, there were financial considerations, and the first object to be gained was to have good line construction and give the people good talking service, after which instruments could be changed at any time it was found necessary.

It might also be asked, why was not the local line between A and B cut in two, thus putting three or four subscribers on each end instead of seven on a single line? Well, if desirable it could be left open at the test station half way between A and B, but as the connections between A and B were principally south rather than north it was thought best to leave them connected.

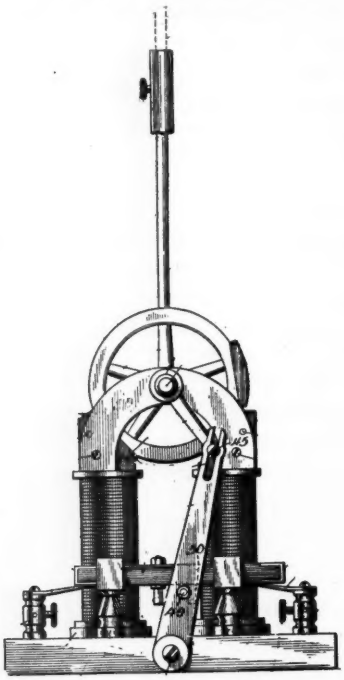
It might also be asked, why was not the local line continued south of B into the exchange, which would give two through lines in case of necessity? To this we would say that the end of the local line was in the exchange territory and the owners of the latter did not wish too many circuits run in until they could change their pole lines, which were then being rebuilt. It will also be noticed that there seems to be no provision for clearing out in the local circuits. To this it may be said that the larger part of the business went to the main line, which took care of the ringing out through the bells in the cord circuit.

So far as local business was concerned ringing out was hardly necessary, as there was no time limit to local conversations, and the clerk cleared out by listening in occasionally.

At the present time it is easy to obtain commutated generators and polarized bells, but at that time it was not.

Electrical Patents

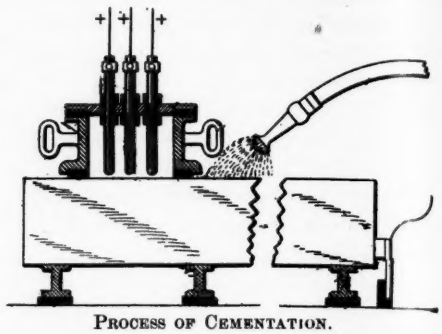
Mr. David P. Burdon, of Jacksonville, Fla., has just obtained a patent on a novel oscillating motor, designed especially to operate swinging fans. His idea is to provide two field magnets, each comprising a plurality of vertical solenoids and operating an armature constructed as follows: A rock shaft is journaled in arches or yokes secured to the opposite sides of the field magnets, and to this rock shaft are secured spaced discs or wheels to the



Oscillating Motion Motor.

peripheries of which are attached armature magnets. These magnets are in the form of bars which are located at a greater distance apart than the distance between the heads of the field magnets, so that when one of the armature magnets is directly adjacent to the coacting field magnet the other will be located above the other field magnet. The motor is designed to be operated by independent batteries, one being connected to each field magnet, and switches for alternately completing the battery circuits are operated by the armature. These switches each comprise a binding-post that carries at its upper end a contact spring. A conductor post is mounted upon the base of the machine contiguous to the free end of the spring, and a bridge piece is mounted to move across the space between the spring and the post and electrically connect the same. To this end the bridge pieces of both switches are secured to the opposite ends of an insulator carrier bar, which bar is slidably mounted in aligned openings made for the purpose in the upper ends of the conductor posts. Lever connections are made between the carrier bar and the armature, so that when the energized field magnet on one side will oscillate the armature in one direction, the carrier bar will be moved to open the circuit of said energized magnet, and to close the circuit of the other. When this occurs, the movement of the armature is reversed and thus the rock shaft is oscillated back and forth as long as the batteries are connected to the machine. Of course a single source of electrical energy may be employed if desired. The fan is attached to the rock shaft through the medium of a long arm having a socket in which the handle is secured, and therefore the fan will be waved back and forth by the movement of the armature.

Lieutenant Cleland Davis, United States Navy, has just patented a novel method of cementing iron or steel. The invention relates to an improved method of cementing or supercarbonizing steel or iron plates or rails, ingots, or like articles made of iron or steel in which it is desired to obtain a hard surface capable of resisting the penetration of foreign bodies or of resisting wear. The invention is particularly adapted to the manufacture of hard-faced armor plate, but it is also applicable to hardening the tread of rails of steel or iron or hardening the face of other plates of steel or iron when desired. In carrying out his ideas the inventor subjects the face of the plate, either progressively or the entire face at one time, to the action of heavy electric currents passing either from carbon electrodes or through a mass of carbon which may be in a granulated form. The face of the plate within the path of the current is soon brought to a high heat and is impregnated to a greater or less depth with particles of carbon carried either from the electrodes or from the mass of granular carbon placed over the face of the plate. The depth to which the carbon will be carried and the consequent hardening which will occur will vary with the electric current and with the time that the treatment lasts. Where it is desired to harden to a considerable depth below the surface, the treatment may be prolonged; but where it is desired to harden only to a slight depth the treatment will be shorter. Since it would be ordinarily difficult to secure current enough to treat the entire face of a large armor plate at one time, it may be preferable to treat portions of the plate progressively, which may be done either by moving the electrodes over the plate or by moving the plate under the electrodes or by shifting the current from one group of electrodes to another, in the mean-



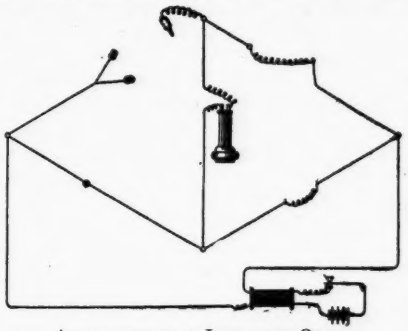
Process of Cementation.

time keeping the plate and the electrodes in the initial position. In the same way, where rails or plates are to be treated the electrodes can be moved along the rail or the rail moved under the electrodes, as may be preferred. Where portions of the plate are treated progressively, the conductivity of the metal will, ordinarily, speedily produce the desired chilling effect, or this may be supplemented by means of a spray of water or other chilling agent.

An Englishman, Mr. Mark Barr, residing at Broad Heath, England, has just patented in this country an exceedingly novel table for metal working machines designed for holding articles while being operated upon. This table is in the form of a metallic box having a plurality of vertical magnetic poles, certain of which are wound and connected to some source of electrical energy. The top of the table is made of brass or some non-magnetic material, and the ends of the pole-pieces pass through the top and are level with its upper surface. The article to be operated upon is secured to a flat metal plate, designed to be placed upon the table top. Suitable abutments are provided for securing this plate against sliding upon the same. It will therefore be seen that as soon as the current is switched into the windings, the coils are energized and magnetic lines of force are created which will act upon the plate and hold it upon the top. The invention has been assigned to the Linotype Company, of London, England.

A divining rod has passed the scrutiny of the United States Patent Office, but it is constructed along somewhat different lines from the old-fashioned forked willow or peach branch. It was designed by Fred H. Brown, a resident of Chicago, Ill., for the purpose of detecting and locating metallic ores, minerals and the like. He provides a pair of metallic rods

of suitable conducting material, such as copper, which are adapted to be inserted in the earth. These rods form terminals of a circuit, which includes a Wheatstone bridge, and the secondary of an induction coil. The primary of this induction coil includes a battery or other source of current, and a suitable circuit-breaker. Included in one branch of the Wheatstone bridge is a rheostat or resistance box, while another branch or leg includes the usual sockets and plug. The other branch includes the fixed resistance, while the bridge portion has connected thereto a telephone receiver. In accordance with the well-known principles of the Wheatstone bridge, when the resistance between the two terminals equals the resistance which is in the circuit, the resistances of the other two branches being equal, then no current traverses the bridge portion and hence no sound or other signal will be produced therein. If, however, the relative resistance of the rheostat and of the circuit between the terminals is varied, then the electrical equilibrium of the bridge is disturbed and a signal will be given in the branch of the bridge; and by removing or inserting resistance in the rheostat, as the case may be, until the equilibrium is again established then the extent of such variation may be measured and determined. This principle is taken advantage of in the practical operation of the invention for detecting or locating ores, minerals or the like in the following manner: The terminals are inserted in the earth a definite predetermined distance apart, and a reading of the resistance box is made, showing the resistance of the earth or portion thereof included in the distance or space which is known between the two terminals. This operation is repeated again and again at various points in the same vicinity, a reading of the resistance being noted in each case. Now, if ores or minerals are present in the vicinity being tested, then, by reason of such presence, the resistance of the earth at that particular point where the measurement is taken will be less than it would be if no ore or mineral were present, by reason of the well-known fact that a current will seek the path of less resistance, and hence by comparing the measurements taken, as above described, the location as well as the presence of the ore may be detected and determined. When the location of the ore or mineral is once determined in the manner described, its depth below the surface of the earth may be determined by varying the distance between the terminals and comparing the corresponding readings of the rheostat. For instance, if the ore is, say, fifty feet below the surface of the earth and the terminals

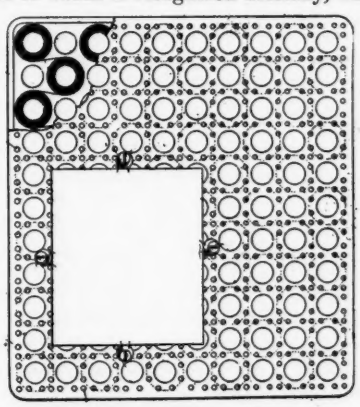


Apparatus for Locating Ores.

are spaced two hundred feet apart then the presence of the ore would be detected, and by repeated tests at varying distances apart of the terminals the exact depth would be determined.

Military Telephones.

The following is taken from the London *Electrical Engineer:* We notice in the *Gazette de l'Electricien* a long description of the military telephone system which has been devised by Captain Charollois, of the French Army. In this article the editor points out that there are two systems of military telephones in use in France, the first of which is recognized officially, while



Magnetic Holding Table.

the other, to which we refer above, is the outcome of private enterprise, and is not recognized as a government system. The authorized military telephones are equipped with batteries, insulated wires and other costly accessories, which are required to give a permanent connection in all states of weather between military outposts. The object of the system devised by Captain Charollois is, however, to obtain a cheap and regular connection between a moving force and headquarters. With this end in view, he uses an insulated wire, which in dry weather is laid direct on the ground. The diameter of this wire is only six-tenths mm., and its weight eight and three-quarters pounds per mile. This enables a man to carry some four or five miles of wire, which is wound on a drum, which can be of exceedingly light construction. Experiments are quoted to show that the system has been exceedingly successful, even when the wire has been laid on a road over which other troops have had to pass. In one instance some seventeen miles were laid and taken up again in the course of a day. The whole question arises, however, as to how far this bare wire, with earth as return, is available in wet weather. We gather that Captain Charollois advises its being supported on trees or houses in times of rain, but it seems to us, after all, that an insulated wire laid on the ground is likely to be of more permanent service. Our corps of electrical engineers has obtained experience in telephone work in the South African War with the use of such insulated wire laid direct on the ground. It will be remembered that Colonel Crompton devised an attachment on a bicycle which enabled the wire to be rapidly paid out across the veldt. In this case the drum was arranged to carry about two miles of bare copper wire. It was found that a cyclist could ride along at the rate of ten to fifteen miles an hour and lay the wire behind him, without any fear of kinking or breaking. After use the wire was picked up by hand at the rate of about four miles an hour. The use of the telephone in South Africa has shown that with a bare copper wire, and using the earth as the return circuit, one can speak for three or four miles with the wire trodden into wet ground, and even with a broken wire. The electrical engineers volunteers' contingent was eminently successful in the use of bicycles for laying the wires, and great advantage was derived from being able to provide speaking communication between two fixed points with such despatch.

Novel Charging System for Telephones.

A new way of charging for telephone service may come into use if the invention recently patented by Thomas Baret, of Sydney, New South Wales, meets with general approval. He proposes to charge for the total length of the conversations and not for the total number. His meter consists of a clockwork device which is at rest except at such time as conversation is being held, and then it is at work registering the actual time consumed by the talk. The up-and-down movement of the switch-lever throws the clock into action, shuts it off and keeps it wound.

MUNICIPAL ELECTRIC LIGHT PLANTS.

AN UNFAVORABLE REPORT ON MUNICIPAL PLANTS BY A COMMITTEE OF THE WORCESTER, MASS., BOARD OF ALDERMEN.

There has been some agitation of the perennial question of municipal ownership at Worcester, Mass., lately, and a committee of the board of aldermen was constituted to enquire into the subject and report upon the feasibility and propriety of that city entering the electric light business. The report, an excellent and sensible document, was adverse to the plan. The report of the committee appears in full below:

In considering the subject matter under this order, your committee has endeavored to discover: First, the results attained by cities already owning municipal electric light plants, as shown by their cost per lamp-hour of street arcs; and, second, the probable cost to the city of Worcester of the plant of the Worcester Electric Light Company and the cost of maintaining this plant under municipal control.

As the cost of fuel, hours of burn and electric energy used in the lamps differ in nearly every city, as the items of interest paid on account of the plant, depreciation of machinery, etc., and of taxes lost are usually ignored in the printed reports sent out from these plants, and as it is necessary to figure these costs upon a Worcester basis, in order to reach an intelligent conclusion in comparing the results arrived at in other cities with our own, your committee caused blank enquiries sent to fifty cities and towns owning and operating municipal lighting plants outside the state of Massachusetts.

The territory covered by these enquiries included practically the entire United States, and the replies were expected to clearly indicate the local conditions and cost of street lighting in the municipal plants of this country.

Unfortunately for this purpose, seventeen cities only replied to the questions asked; of this seventeen the replies received from nine were so incomplete as to render the data of no value, leaving only eight plants outside the state the data from which were sufficient to be of use.

The cost of street lights as reported by these eight cities, plus the difference in cost of coal in these eight cities and in Worcester, plus the items of interest paid, depreciation and taxes lost (which were omitted in every case), shows the average cost per lamp-hour would be 3.4 cents if the plants were located in this city.

Inasmuch as the price paid in this city for street arcs is 2.8 cents per lamp-hour, or 0.6 cent cheaper than the cost of the same light, burned under equal conditions, in the municipal plants outside the state, your committee abandoned this line of investigation and took up the municipal plants within the state.

Massachusetts cities and towns owning their own lighting plants are obliged to keep their books according to a system adopted by the State Board of Gas and Electric Light Commissioners and to charge items of expense to the general account designated by the board.

This system is identical with that prescribed by the board for the companies, and affords the only correct basis of comparing the costs of production by the municipal plants and the companies.

The average cost per lamp-hour of the street arcs furnished by the municipal plants in this state, as shown by the reports of the board, is 4.34 cents, while the price paid in this city is 2.8 cents per lamp-hour since July 1, 1901. It must not be forgotten that, with two exceptions, the municipal plants in Massachusetts burn a 300-watt lamp, while we use a 500-watt lamp in this city.

Adding the cost of coal necessary to produce a 500-watt instead of a 300-watt lamp, the cost per lamp per hour would be increased from 4.34 to 4.58 cents, a sum very nearly double that now paid for street lights by the city of Worcester.

It is undoubtedly true that the cost of street lights in cities of this state, operating municipal plants, is largely affected by the amount of commercial business done by the plant, as a large deficit in commercial operation adds to the cost of the street lights, while a small deficit in commercial lighting correspondingly lessens the cost of the street service.

It is also true that the condition and amount of commercial business in this city would be more favorable to the success of the plant under municipal control than in many cities of the state, as the commercial business taken by the city with the plant of the Worcester Electric Light Company is relatively greater, when compared with the street lighting, than that done by many municipal plants in Massachusetts.

In Taunton, however, the ratio seems to be very equal to that existing in this city.

Taunton has 227 street lights and the equivalent of 5,946 sixteen-candle-power commercial lamps, while Worcester has 700 street arcs and a commercial business of 19,000 sixteen-candle-power lamps.

From data supplied this committee by the officers of the Taunton plant, the following facts appear:

The plant was purchased July 1, 1897, at a cost of $125,000. The investment in the plant to date amounts to $151,000, $26,000 having been added during three and one-half years.

They have 227 street lights of 1,200 candle-power burning 3,400 hours per year, the reported cost of which is $72.96 per lamp per year. Reducing this reported cost to Worcester basis as regards the price of coal, adding taxes lost and the additional coal necessary to burn 2,000-candle instead of 1,200-candle lamps, the cost per lamp-hour would be 2.85 cents, as against our present price of 2.8 cents, and it is no secret in electrical circles that the city of Taunton will soon be obliged to spend at least $50,000 on its plant in order to bring it up to the duty required of it.

The additional requirements for interest, etc., made necessary by this investment, will probably increase the cost of street arcs in Taunton to three cents per lamp-hour, if figured upon the Worcester basis as regards cost of coal and hours of burn.

That the consideration of this matter of municipal ownership is not new to the cities in this state, but has been thoroughly investigated by business men from a business point of view, is shown by the action of the city of Boston.

After a thorough investigation of the matter during Mayor Matthews's administration, in which several estimates of both cost and maintenance were made, a contract was made by Mayor Quincy for ten years' service on a sliding scale, ranging from thirty-five cents per light per night for 2,749 lamps to thirty cents for 5,000 lamps, all lights to use 500 watts energy and to burn, as in this city, 3,900 hours per year.

The town of Brookline, after much careful enquiry into the probable cost of electric street lights under municipal ownership, conducted by experts of the highest standing, contracted for 500-watt lamps burned 3,900 hours per year, costing thirty-five cents per light per night.

The city of Springfield investigated the subject of municipal ownership, and, after careful consideration, renewed its contract with the local company.

On the other hand, the town of Hudson acquired its electric light plant under the present law, and the cost per lamp-hour for the lights used on the streets is more than three times that paid in this city.

The experience of the town of Wakefield has its lesson. According to data furnished this committee by the municipal plant of that town, the price formerly paid under contract was $75 per lamp-year for 1,200-candle-power lamps burning five and one-half hours per night. Its plant was established in 1894 at an original cost of $164,000. The investment in the plant to date is $180,000. The town uses 1,200 candle lamps burning six hours per night, and the reported cost is $74.68 per lamp-year. The town, plainly, loses the taxes formerly paid by the corporation, which amounts to $12.14 per lamp-year, making the true cost $86.82 per lamp-year with the municipal plant, as against $75 per lamp-year under contract, the burn being practically the same.

It has been noted that the local conditions in Worcester are different, in some respects, from those existing in many cities of the state where municipal plants have been established.

The really important point, then, is the probable cost of acquiring the Electric Light Company's plant and the cost of operating it when it is acquired.

The exact wording of the paragraph of Chapter 370, Acts of 1891, which fixes the value of plants taken, is:

"And the price to be paid therefor (*i. e.*, the existing plant) shall be its fair market value for the purposes of its use,

no portion of such plant to be estimated, however, at less than its fair market value for any other purpose, including, as an element of value, the earning capacity of such plant, based upon the actual earnings being derived from such use at the time of the final vote of such city or town to establish a plant and also of any locations or similar rights acquired from private persons connected therewith."

Your committee has been unable to obtain a construction of this paragraph from the city solicitor, and, after careful consideration and consultation with several parties of practical experience in transactions of this sort, can see no other fair interpretation of the above quoted statute than that the probable value of the plant is indicated by the market value of the company's stock at the date of the final vote in favor of the taking, as the investing public takes all the elements of value named in the statute into consideration in naming the price which it is willing to pay for shares in the company. In this case, the stock of the Worcester Electric Light Company is worth at least $210 per share, that being the price at which the last issue sold in open market. The company is capitalized for $600,000 and has no bonds outstanding.

This makes the property worth, according to the judgment of investors, $1,260,000, which is the minimum amount the city would probably be obliged to pay for the plant if taken under the statute.

The legal requirements for interest, sinking funds and depreciation aggregate twelve per cent of this amount, or $151,200 per year, as the minimum of fixed charges which must be earned under municipal ownership.

As the city can work its men only eight hours per day, and the company calls ten hours a day's work, it would, therefore, be necessary to add at least twenty-five per cent to the present payroll of the company.

The city certainly can not, under these conditions, operate the plant more cheaply than the corporation has been able to do.

The running expenses of the company under its present management is, then, a very conservative basis for estimate. We find that the running expenses of the company last year, exclusive of dividends and depreciation, with no interest to pay, was in round numbers $124,000, to which should be added the $151,200 required for sinking funds, interest and legal depreciation, making a total of $275,200 which it will cost to operate the plant under municipal control.

The total business of the company last year, including the amount paid it by all the city departments, amounted to $236,000 only, showing that the entire business of the company was $39,000 less last year than the amount needed to operate the plant and pay the legal charges upon it under municipal control.

If, following its usual custom, the state board charges the deficit in commercial operation to the cost of the street lights, the cost of the street lighting service, in the event of the city's acquiring this plant, will be increased from $79,000 to $118,000 per year for the electric lights alone; the cost of the arcs will advance from $109.50 to $168 per lamp per year and from 2.8 cents to 4.95 cents per lamp per hour.

No reference is made in the foregoing calculation to the taxes now paid by the company into the city treasury, adding not less than $8,000 per year to the deficit already noted.

Your committee believes that the same conditions and reasoning apply with equal force to the property and business of the gas light company.

This company is capitalized at $500,000 and has assets, according to its last report, of $733,000. Its stock is worth not less than $225 per share on the market, thus making its property too valuable for us to acquire under the statute.

As the result of the foregoing investigation, your committee recommends that it is not expedient for the city of Worcester to exercise the authority conferred in Chapter 370 of the Acts of 1891 and Acts in Amendment thereto, in the matter of acquiring a municipal electric light plant.

Magnetostriction of Some Ferromagnetic Substances.

Messrs. H. Nagaska and R. Honda, of the Imperial University, Tokyo, Japan, write to *Nature* as follows:

"We avail ourselves of your valuable journal to give a short notice of some new results, obtained in our researches on magnetostriction, being a continuation of our investigation on the same subject, given in the 'Rapports présentés au Congrès international de Physique,' t. ii., by one of us.

"It was generally believed that ferromagnetic bodies show change of length by magnetization, but not of volume. Minute as the effect generally is, it is now placed beyond dispute that iron, nickel, cobalt and especially steel differ also in bulk in the magnetized state from that in the unmagnetized. In the course of our researches on the magnetostriction of different ferromagnetic bodies in the form of ovoids we came across a substance which shows a remarkably large increase of volume.

"Examining the magnetostriction of reversible nickel steels of different composition, which were kindly placed at our disposal by Dr. Guillaume and M. Dumas, we find that alloys containing 46 per cent, 36 per cent and 29 per cent of nickel all show increase of length several times greater than that observed in ordinary iron. But far more striking is the change of volume of the three above-mentioned alloys, the effect increases as the percentage of nickel becomes less; with 29 per cent alloy we observed a motion of 5 mm. of the liquid in the capillary tube (diam. 0.4 mm.) attached to the volumenometer containing the specimen (volume $v = 10$ c.cm.) under examination. Thus the greatest change of volume by magnetization amounts to $\delta v/v = 51.1 \times 10^{-6}$ in $H = 1690$ C.G.S. With ordinary iron, the same change $\delta v/v = 1.2 \times 10^{-6}$ in the same field, being only about 1/40th of that observed in nickel-steel. The magnetization of 25 per cent nickel alloy is so feeble that it is impossible for it to be magnetometrically measured, and the change of length is inappreciably small, but the volume change is measurable and amounts to 0.2×10^{-6} in $H = 1790$. It is thus quite probable that there is an alloy containing somewhat more or less than 29 per cent of nickel that indicates largest increase of volume by magnetization.

"We at first thought it would be possible to trace some connection between the thermal expansion and the change of length by magnetization. No such relation seems to exist; the 36 per cent alloy, which is the least expansible by heat, indicates tolerably large elongation by magnetization.

"As regards the Wiedemann effect, nickel steels behave very much like iron, showing the maximum amount of torsion in moderate fields.

"As is well known, the behavior of cast cobalt, as regards the change of length by magnetization, is opposite to that of iron, but the volume change in the same metal is much smaller. By annealing cobalt in a charcoal fire it assumes a pale, ashy color, and the magnetic character is greatly changed. The metal becomes less magnetizable, and shows constant decrease of length accompanied by increase of volume.

"We have also found, by actual experiment, that the effect of stress on magnetization and the magnetostriction in cobalt and in nickel steel are reciprocally related to one another, as was already established for iron and nickel."

Light-Wave Phenomenon.

Professor P. Zeeman, writing in the *Archives néerlandaises,* describes an experiment relating to the change of phase which occurs when a pencil of light waves passes through a focus or focal line, a phenomenon to which Gouy has given the name of anomalous propagation. The experiments were made with a plano-convex lens of Iceland spar placed between two crossed nicols, and consisted in observing the rings produced by interference of the ordinary and extraordinary rays. When the centre of the system is black or white between the two foci, M. Gouy's theorem shows that it must be white or black respectively beyond the foci. Professor Zeeman also gives an independent mathematical investigation of the phenomenon based on treating the focus as a doublet.

THE COMMERCIAL IMPORTANCE OF ALUMINUM—II.

BY PROFESSOR ERNEST WILSON.

Taking the specific resistance of aluminum at 2.76 and copper at 1.696×10^{-6} ohms (Matthiessen's standard) at fifteen degrees centigrade, the diameter of the aluminum wire will be 1.27 that of the copper. For equal conductivity it follows that the insulation on covered aluminum wires will be greater, but the covered wire will be still less in weight than the copper. It is as a bare conductor for long-distance transmission that aluminum has been largely used, and it is therefore necessary to consider the tensile properties and change in length due to change in temperature. The commercially pure aluminum alluded to above has, when in the form of wire 0.126 inch (3.2 millimetres) in diameter, a breaking load of 28,200 pounds (12.6 tons) per square inch, a limit of elasticity 19,376 pounds (8.65 tons) per square inch, and percentage extension 0.19 within the limits of elasticity with an applied force of 16,250 pounds (7.2 tons) per square inch. Alloying this aluminum with copper, zinc, nickel or iron in varying proportions to the extent of about two per cent, increases the tensile strength at the expense of conductivity. It is, therefore, important to know what the tensile properties have to be in particular cases. The Standard Electric Company, of California, in its forty-three miles of transmission line, employs aluminum wire 0.294 inch in diameter having a resistance per mile of 1.008 ohms at twenty-five degrees centigrade, and this is stated to have a conductivity of 59.9 per cent of copper. The breaking load is 22,800 pounds (10.1 tons) per square inch. No limit of elasticity is given, but it is stated that at 14,500 to 17,000 pounds per square inch there is a marked increase in the permanent set, which was taken to indicate the limits of safe working load. It may be here mentioned that the tensile properties of aluminum are increased by rolling, hammering or drawing. In testing wires, therefore, different results may be obtained from the same material by varying the amount of drawing down. Copper and nickel-copper alloys can give about twenty tons breaking load, sixteen tons limit of elasticity, percentage extension 0.19 with 7.2 tons per square inch applied, and conductivity about fifty-two per cent of copper. Now, hard-drawn copper has a breaking load of about twenty-eight tons, and limit of elasticity twelve to thirteen tons per square inch, a percentage extension of 0.10 with 7.2 tons applied per square inch, and a linear coefficient of about 0.000017 per one degree centigrade. These light aluminum alloys can have a limit of elasticity exceeding that of copper, their percentage extension under a given load within the limit of elasticity is greater (about two-fold) than copper, and the linear coefficient of expansion is greater. The properties of the elastic catenary, together with the superposed effect of change of temperature, have been examined, and they show that the greater lightness and greater percentage of extension counteract the effects of greater lineal coefficient of expansion. In fact, the factor of safety with regard to the elastic limit is greater than in copper under the same conditions.

Wind Pressure—The Board of Trade regulations require a factor of safety of six aerial lines, taking the maximum wind pressure at fifty pounds per square foot. In a copper wire 0.4 inch in diameter, the resultant force per foot-length, due to gravity and such a wind pressure, may be double that due to gravity alone. With aluminum of the same conductivity, the wind pressure will be about 1.27 greater than with copper. Since the cross-sectional area of a wire varies as the radius squared, and the area exposed to wind pressure, snow, etc., varies as the radius, it follows that for a given material the larger the diameter the better. In other words, two separately strung wires of equal diameters are not so good as one wire of $\sqrt{2}$ the diameter of either the other two, although the total conductivities are the same in the two cases. But comparing aluminum with copper, the total tensile strength of an aluminum wire of the same conductivity as the copper may be greater according to the alloy chosen, and this may compensate for the increase in the surface exposed to wind, etc.

Surface Effect—If the mathematical theory of Lord Kelvin be examined, it will be seen that, provided the electrical resistance to steady currents is the same in each wire of a series of non-magnetic wires of the same length, but of different specific resistances, and consequently different diameters, the increase in electrical resistance, due to frequency, is the same in each of the wires. It can not therefore be urged against the larger diameter (1.27) of aluminum, as compared with copper, that this effect is increased. Indeed, the self-induction is reduced by the larger diameter of the aluminum for equal conductivity.

Electric Glow—In the case of aerial wires between which exist some thousands of volts potential difference, it is well known that the wires glow on account of the intense electrification of the air in the neighborhood of the wire. This effect is a function of the radius of the wire. The mechanical pull varies as

$$\sqrt{(\text{field strength} \times \text{radius of curvature})}$$

for points (see Chattock, *Philosophical Magazine*, September, 1891). The increased radius of the aluminum for the same conductivity as copper would help to reduce electric glow. The film which forms on aluminum in the presence of moisture is known to consist of basic aluminum sulphate, and the author has found that it possesses a high electrical resistance when dry. This may have importance, in the case of overhead conductors, in diminishing glow discharge.

Some Long-Distance Transmissions—A full description of all the long-distance transmission schemes would be out of the question here. The following are brief notes to give a general idea of what has been accomplished. At Northallerton, England, four miles of overhead aluminum wires are employed. Screwed socket joints have proved successful. At the Snoqualmie Falls, twenty miles of overhead conductors convey current to Renton, where the line divides, one-half going to Seattle and the other to Tacoma. About 139,000 pounds of aluminum are employed. The horse-power is 12,000 and the voltage is 30,000. McIntire joints are employed. This joint consists of a tube nine inches long, of aluminum, flattened, and large enough to enclose both wires; by special clamping tools three complete twists are given and the joint is complete. The Blue Lakes transmission scheme has forty-three miles of overhead wires. The poles are 132 feet apart. The aluminum used in this undertaking has been referred to before. As indicating the satisfaction given by aluminum, it may be mentioned that in the new line about 1,000,000 pounds of aluminum will be required in the form of stranded conductors, three-quarters of an inch in diameter. The Pittsburgh Reduction Company has received orders for 150,000 pounds of aluminum for the feeders on the Northwestern Railway, Chicago. The Hartford Electric Light Company has thirty-three miles transmission, 2,000 horse-power at 10,000 volts, three-phase. The cable, three-quarters of an inch in diameter, consists of seven strands. The Kansas City & Leavenworth Electric Railway line is using seventy-six miles of aluminum cable. At Waterport, U. S. A., a

six and one-half miles transmission is employed. The conductor consists of a seven-strand cable supported on thirty-foot poles 100 feet apart. The Niagara Falls Power Company has about completed its second power transmission line between the Falls and Buffalo. The three-phase current is transmitted by three aluminum cables, each composed of thirty-seven strands. The span between the poles, which in the old copper lines is seventy-five feet, averages 112½ feet in the aluminum line. An electrical transmission plant has been completed in the valley of Pompeii, near Naples, in which aluminum is employed for the line wires. Three lines emanate from the power-house —two miles, nine miles and two miles long respectively. In Provo Canyon, three aluminum cables, each of seven strands, transmit over forty miles to Tintic, which is connected with Mercur, thirty miles distant, and electric current is transmitted to Mercur *via* Tintic, as readily as by the direct line between Mercur and Provo. In this manner, if one line is out of order, power can be transmitted by the other.

Joints—It has been urged against aluminum that it gives trouble in jointing. The ordinary metals are strongly electro-negative to aluminum, so that if other metals than aluminum be used in jointing, galvanic action will occur in the presence of moisture. In the above power transmissions mechanical joints have been made with success; but, with proper precaution, aluminum wire can be welded either by the use of the blow-lamp or electrically. The following tests will show that welding can be successfully accomplished. The original trolley wire (eight sections) has an area of 0.135 square inch, and a breaking load of 1.6 tons on that section, with 11.3 per cent extension, the welded joint gave 1.2 tons breaking load, with eight per cent extension, the joint not being broken. An aluminum wire, 0.6 inch in diameter, having a breaking load of 3,449 pounds, with fourteen per cent extension, gave 2,912 pounds breaking load, when welded with eight per cent extension. Hard and soft solders are supplied by the British Aluminium Company. It is necessary to break up the one which forms on the surface of the aluminum, and with care aluminum soldering is rendered easy.

Melting and Casting—Aluminum can be melted in plumbago or sand crucibles without becoming brittle or taking up silicon, provided that the temperature does not much exceed 626 degrees centigrade, or 1,160 degrees centigrade its melting point. The shrinkage of pure aluminum is 0.20 inch to the foot, as compared with 0.187 inch for copper.

Aluminum for Iron and Steel Founders—The addition of aluminum to iron or steel has the great advantage of keeping the metal more fluid in the ladle, thus saving by the avoidance of blowholes. At high temperatures the metal decomposes nearly all metallic oxides, and prevents blowholes by combining chemically with the gas which forms the holes. Its action is stated to be about twenty times as powerful as silicon, and the resultant steel is superior in toughness and ductility. The quantity to be added varies according to the iron used. Generally the amount runs from two pounds to five pounds per ton of iron.

Rolling and Forging—The great ductility of aluminum makes it easy to work with rolls. Rolled sheet aluminum, 0.001 inch thick, is used for decorative purposes. In fact, leaf aluminum may be said to have replaced leaf silver. It can be forged easily either cold or warm. Aluminum containing much silicon and iron can only be forged with greater difficulty.

Hardening and Annealing—The hardness of aluminum varies according to its purity, the purest metal being the softest. Ordinary ninety-eight per cent aluminum is about as hard as copper. Aluminum becomes harder the more it is worked by rolling, drawing, stamping or hammering. The metal must be annealed in a close muffle, and must not come in contact with the open fire.

Drawing and Stamping—Professor Thurston places aluminum as sixth in the order of ductility, being preceded by gold, silver, platinum and copper, but it is doubtful if it does not rank as high as iron. Aluminum can be pressed or stamped under the drop hammer, hot or cold. Very fine effects can be produced by first burnishing the metal and then stamping in polished dies.

Heavy Alloys—Aluminum Bronzes—In 1899 and 1890 papers were read before this section on aluminum bronzes. It was then pointed out by Mr. J. H. J. Dagger, F. C. S., F. I. C., that for artillery, small arms, propeller blades, stern rudder frames and hydraulic work, the non-corrodible properties and great strength of these alloys rendered them most valuable. Aluminum bronze propellers have been successfully employed for high-speed torpedo catchers. The two classes of bronze most frequently used contain from twelve to eight per cent aluminum and eighty-eight to ninety-two per cent copper, and have a golden appearance and the strength of steel. The breaking load in tons per square inch varies from forty-four to thirty-nine, with an average elongation of nine per cent and thirty-eight to thirty-four tons per square inch, with an average elongation of twenty-one per cent. They have high elastic limit and transverse strengths.

Where forgings or stampings are required, four classes of bronze are recommended, containing respectively ten, seven and one-half, five and two and one-half per cent aluminum, the rest being copper. The specific gravities vary from 7.6 to 8.3, the tensile strength varies in castings from thirty to twenty tons per square inch, and the elongation varies from twenty-two to forty per cent.

Uses of Pure Aluminum—The uses of aluminum are very numerous. Probably the widest field is still in the purification of steel and iron. It appeals to the public as a material for constructing cooking utensils. It is not brittle like cast iron, nor does it rust like tinplate. It is used for internal fittings for ships instead of wood, for motor car parts, and boiling pans for confectionery. The Admiralty employs it, and on the Continent soldiers are equipped with it when possible. It is used in a modified form of lithography as a substitute for solenhofen. We have seen that with the increasing price of copper, aluminum is being used largely for conductors of electricity. It can be used for roofing houses. There is no reason why it should not be used to replace the present heavy bronze coinage. It wears beautifully bright and clean, and is sufficiently hard for this purpose.

American Institute of Electrical Engineers.

The next meeting of the American Institute of Electrical Engineers will be held on the evening of February 14, in the electrical laboratory of Columbia University, New York city, when a paper will be presented by Mr. Percy H. Thomas, entitled "Static Strains in High-Tension Circuits and the Protection of Apparatus." This will be elaborately illustrated by experiments and demonstrations.

Wireless Telegraphy for Scotch Lighthouses.

It has been decided to adopt the Marconi system of wireless telegraphy in connection with the lighthouses round the north and west coasts of Scotland. The Commissioners of the Northern Lighthouses of Scotland have the matter in hand. They propose to carry out the first installation at the Flannan Islands, which are about sixteen miles off the west coast of Lewis. This is practically the first land sighted by vessels coming from America, and a wireless telegraphy station at such a point will doubtless prove of great value.

THE RISE OF ELECTRIC RAILWAYS IN MASSACHUSETTS.

ALTON D. ADAMS.

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Horse railways reached the meridian of their development in this state with a total length of 532.95 miles of main track in 1888. For that same year the entire length of electric railway was included in a single experimental road with only 0.64 mile of main track.

By the last of September, 1889, the length of main track for horse railways had shrunk to 523.65 miles, and the length for electric roads had expanded to 50.52, making a total of 574.17 miles of street railway lines. The year of 1889 thus saw the electric system fairly started on that course which has resulted in the extinction of horse railways. The first electric street railway in Massachusetts was started at the town of Revere in 1888, with the length of road stated for that year and one car. This electric railway operated only twenty-four days in the year just named. In 1889 the East Side, Lynn & Boston, Lowell & Dracut, Marlboro, Naumkeag, Plymouth & Kingston, and West End Street railways were added to the Revere as users of the electric system. The Revere railway was extended and its name changed to the Boston & Revere. This last was the first system in the state to be operated entirely with electric power. The West End Street Railway, of Boston, used electric cars successfully on February 16, 1889, for the first time.

After 1889 the electric replaced horse lines rapidly. During every year from 1890 to 1897 inclusive, the added length of electric track was sufficient to cover all extensions of street railways, and to reduce the length of horse lines besides. In 1892 the horse lines had lost their supremacy as to length of track, the figures for main line in that year being 258.55 miles with horse and 496.30 miles with electrical equipment. Only 4.76 miles of horse lines remained in 1899, 2.74 miles of which were in Boston on streets where overhead construction could not be used, and the length of electric line stood at 1,730.78 miles. In 1900 the horse railway remained at the figure just stated, and the electric rose to 1,908.69 miles.

A great extension of street railways has taken place along with the change from the horse to the electric system. In 1888, the year when electric operation began, there were 533.59 miles of main track. For 1900 the track length was 1,913.45, or 3.5 times that of the earlier year. A very large part of this increase must be put to the credit of the electric system, in the sense that it would not have taken place without that system. From 1870 to 1888 the length of horse railways increased only 393.51 miles, an average of 21.3 miles per year. Electric railways between 1888 and 1900 not only displaced all except 4.76 miles of the horse lines, but also added 1,379.22 miles of original lines, or an average of 114.93 miles per year.

LENGTH OF MAIN TRACK OWNED BY STREET RAILWAYS IN MASSACHUSETTS.

Year of Sept. 30.	Miles Main Track.	Miles Horse Lines.	Miles Electric Lines.	Miles Increase of Total.
1888	533.59	532.95	0.64	....
1889	574.17	523.65	50.52	40.58
1890	612.38	451.52	160.86	38.21
1891	672.45	383.42	289.03	60.07
1892	754.85	258.55	496.30	82.40
1893	874.14	163.06	711.08	119.29
1894	928.84	103.87	824.97	54.70
1895	1,077.99	61.80	1,016.19	149.15
1896	1,276.75	35.13	1,241.62	198.76
1897	1,413.66	11.95	1,401.71	136.91
1898	1,537.98	7.50	1,530.48	124.32
1899	1,735.54	4.76	1,730.78	197.56
1900	1,913.45	4.76	1,908.69	177.91

YEARLY INCREASE IN MILES OF ELECTRIC TRACK.

1889...49.88	1893...214.78	1897...160.09
1890..110.34	1894...113.89	1898...128.77
1891..128.17	1895...191.22	1899...200.30
1892..207.27	1896...225.43	1900...177.91

The greatest increase of electric track in any one year is shown for 1896, when 225.43 miles were added, or changed from horse lines. During each year, save one, from 1889 to 1895 the increase of electric track was more than twice the increase for both horse and electric lines. The largest total increase of main track was made in 1896, but the miles added in each of the years of 1898 and 1899 were nearly up to this maximum. It seems probable that electric railways have not passed their period of greatest extension, and it may even be doubted whether they have reached it, in view of the increasing tendency to high-speed, long-distance work.

In 1889 the horses included in the equipment of street railway companies reached their maximum number of 11,817. As the length of track operated with horses decreased their number went down, though not at the same rate. With more than three times the miles of track in 1900 that were operated in 1889, the number of horses retained by street railways had fallen to 455. Of this last number of horses all were employed on work apart from car traction, except those sufficient to operate 4.76 miles of track. While the horse has gone out of service the electric motor has taken up his load. In 1888 a single electric motor propelled a small car on the experimental road at Revere. By the last quarter of 1893 the number of motors on street railways had gone up to 3,013, and they had replaced 7,860 of the horses used in 1888, besides doing the increase of work in car traction.

Electric motors to the number of 9,545 were employed on street cars in 1900, or five for every mile of main track owned by the companies.

In 1888 there were twenty-one horses employed on street railways for every mile of main track owned. In relation to miles of track it thus seems that one motor takes the place of four horses if traction per mile remains constant.

EQUIPMENT OF STREET RAILWAYS.

Year Ending Sept. 30.	Number of Horses.	Number of Motors.	Number Electric Cars.	Total Number Cars.
1888	11,391	....	....	2,588
1889	11,817	....	....	2,942
1890	11,241	....	....	3,247
1891	10,640	....	....	3,494
1892	6,706	....	....	3,659
1893	3,531	3,013	....	4,040
1894	2,014	3,906	2,787	4,058
1895	1,436	4,704	3,431	4,426
1896	878	5,958	4,262	4,913
1897	683	6,908	4,807	5,344
1898	605	7,643	5,247	5,734
1899	455	8,530	5,616	6,042
1900	455	9,545	6,214	6,531

The car equipment of all street railways numbered 2,588 in 1888, and had risen to 6,531 in 1900, being 2.52 times as great in this later year. For 1888 the average number of cars per mile of main track was 4.85, and in 1900 this average had fallen to 3.41 cars per mile of track. Of all cars in 1894, 2,787, or sixty-eight per cent, were electric, while for 1900, 6,214, or ninety-five per cent of the total number of cars, were electric. There were in use in 1894 1.40 motors for each electric car on an average, and in 1900 this average was 1.53 motors per electric car. These figures clearly show that in 1900 3,331 cars had two motors each and $6,214 - 3,331 = 2,883$ cars had one motor each. If x represents the number of cars with one motor each, and y the number with two motors each, then $x + 2y = 9,545 =$ total motors. But $x + y = 6,214 =$ total electric cars. Consequently, subtracting equation, $y = 9,545 - 6,214 = 3,331 =$ number of cars with two motors each. Apparently the change from one to double-motor equipments is going on but slowly.

With horse traction at all points except Revere in 1888, the total car-miles of operation were 23,244,767, and in 1900, with electric motors, the figure reached 81,750,768, or 3.5 times that of the earlier year. As the miles of main track in 1900 were 3.5 times the length in 1888, it seems that car-miles and track length have increased at the same rate. Horses drew each car 8,981 miles on an average in

1888, but in 1891 the addition of new electric cars reduced the average yearly run to 7,919 miles per car. Since 1891 there has been a constant increase in the travel of each car, culminating with 12,517 miles in 1900. The average run of each car in this latest year is thus 1.4 times that with horse traction in 1888. If the number of hours of yearly operation per car was equal in 1888 to that in 1900, it follows that the speed of street cars has increased forty per cent on an average. In 1888 the car-miles of operation per mile of main track were 43,562, and in 1900 the corresponding figure was 42,724. It thus seems that the number of cars passing over each mile of track yearly has remained nearly constant on an average.

CAR-MILES OF OPERATION.

Year of Sept. 30.	Total Car-Miles.	Car-Miles per Car.	Car-Miles per Track-Mile.
1888	23,244,767	8,981	43,562
1889	24,259,491	8,245	.....
1890	26,516,937	8,166	.....
1891	27,670,166	7,919	.....
1892	29,678,036	8,110	.....
1893	34,507,282	8,541	.....
1894	36,722,978	9,049	.....
1895	43,655,560	9,863	.....
1896	53,613,685	10,912	.....
1897	61,577,917	11,522	.....
1898	68,206,418	11,895	.....
1899	73,367,235	12,132	.....
1900	81,750,768	12,517	42,724

Round trips made by street cars in 1888 numbered 3,220,578, and for 1900 they were 2.3 times as numerous, standing at 7,818,427.

The miles per round trip went up with the number of trips, from 7.2 in 1888 to 10.4 miles in 1900. This increase in the average length of a round trip, amounting to forty-four per cent during the period named, carried with it in many cases a longer ride for a single fare.

The average speed of street cars went up forty per cent from 1888 to 1900, as was shown above, so that an increase of forty-four per cent in the length of round trips must have meant fewer of these trips per car. Such a result is found to have been the actual fact by a division of the number of round trips in 1888 by the number of cars in that year, giving 1,244.4 trips per car, and then a division of the number of round trips for 1900 by the number of cars in that year, giving 1,197.1 round trips per car.

There was a decline from 7.2 to 6.9 miles per round trip between 1888 and 1891, due probably to the fact that shortly after the introduction of electric cars the number of passengers and of round trips went up before existing track systems were greatly extended. After 1891 the extensions for suburban and interurban service show their effect in the increasing length per round trip. In spite of the fact that 2.3 times as many round trips were made by street cars in 1900 as in 1888, the number of passengers carried per round trip increased from forty-two to fifty-one during the period, or twenty-one per cent. This increase of passengers per round trip did not keep pace, however, with the growth of forty-four per cent in the average number of miles per round trip in the same years.

ROUND TRIPS MADE BY ALL CARS.

Year of Sept. 30.	Number of Round Trips.	Miles per Round Trip.	Passengers per Round Trip.
1888	3,220,578	7.2	42
1889	3,446,769	7.0	43
1890	3,764,816	7.0	44
1891	3,958,455	6.9	44
1892	4,168,458	7.1	47
1893	4,481,171	7.7	48
1894	4,662,786	7.8	47
1895	5,179,234	8.4	50
1896	6,004,809	8.9	49
1897	6,557,183	9.3	47
1898	6,887,976	9.9	48
1899	7,104,843	10.3	50
1900	7,818,427	10.4	51

It should be noted that the number of passengers per round trip reached fifty in 1895, but fell back to forty-seven in 1897. This movement seems to have been due to the very rapid development of new street railway lines during these years, the increase in the length of main track from 1895 to 1897 having been thirty-one per cent.

Greater than that for the number of street cars, greater than that for total car miles, greater than that for miles per car, greater than that for total round trips, has been the per cent of increase for the number of passengers carried between the years 1888 and 1900. In the earlier year the number of passengers was 134,478,319, and in the later the figures stood at 395,027,198, an increase of 1.93 per cent in twelve years.

This increase amounts to an average of sixteen per cent yearly on the number of passengers in 1888. In 1882 the number of passengers carried by the horse railways was 83,923,577, and the number just given for 1888 shows an increase of sixty per cent over this figure of the earlier year. The average rate of increase for passenger traffic on the horse railways during the six years was thus ten per cent of the figures for 1882. From 1882 to 1883 the rise in the number of passengers carried was 4,306,219, and from 1887 to 1888 the like rise was 9,690,991. With the advent of electric railways in 1889, the increase of passengers over the previous year was 13,710,084, and for 1900 the yearly increase stood at 38,302,985.

For the intervening years the largest yearly addition to the number of passengers was made with 39,330,209 in 1895, this increase being eighteen per cent of the number in the previous year, and the largest for the entire period.

The density of traffic, or the number of passengers carried per mile of main track owned by the street railway companies, has declined in spite of the rapid rise in the number of passengers carried. Such a result is due to the great extensions of suburban and interurban lines, which have carried up the miles of main track at an even greater rate than the increase of passengers. For 1888 the number of passengers carried per mile of main track owned was 252,023, but by 1900 the figures decreased to 206,452.

PASSENGERS ON STREET RAILWAYS.

Year of Sept. 30.	Total Passengers Carried.	Increase for Year.	Per Cent of Increase.
1888	134,478,319	9,690,991	7
1889	148,189,403	13,710,084	10
1890	164,873,846	16,684,443	11
1891	176,090,189	11,216,343	6
1892	194,171,942	18,081,753	10
1893	213,552,009	19,380,067	10
1894	220,464,099	6,912,090	3
1895	259,794,308	39,330,209	18
1896	292,358,943	32,564,635	13
1897	308,684,224	16,325,281	6
1898	330,889,629	22,205,405	7
1899	356,724,213	25,834,584	8
1900	395,027,198	38,302,985	11

A division of the total number of passengers in each year by the number of car-miles, indicated the average number of passengers carried for each mile that a street car was operated. This average for 1888 was 5.7, and for 1900 it was 4.8, indicating that the new and longer trips of street cars have cut down the traffic per mile. The number of passengers carried per car tells a different story and shows a decided increase. For the year of 1888 each car owned by the street railway companies carried on an average 51,960 passengers. In 1900 this average stood at 60,484 passengers, and represented an increase of 16.4 per cent over the earlier year. This increase was not constant, however.

RATIO OF NUMBER OF PASSENGERS TO NUMBER OF MILES OF MAIN TRACK OWNED, TO CAR-MILES AND TO NUMBER OF CARS.

Year of Sept 30.	Passengers to Miles—Main Track.	Passengers to Car-Miles.	Passengers to Number of Cars.
1888	252,023	5.7	51,960
1889	268,093	6.6	50,370
1890	269,234	6.2	50,777
1891	261,881	6.3	50,397
1892	257,245	6.5	53,067
1893	244,299	6.1	52,859
1894	237,354	6.0	54,328
1895	240,998	5.9	58,697
1896	228,986	5.4	59,506
1897	218,358	5.0	57,762
1898	215,145	4.8	57,706
1899	205,540	4.8	59,040
1900	206,452	4.8	60,484

During the years from 1888 to 1891, when new electric cars were being added to equipment and old horse cars were piling up on the hands of the companies, the number of passengers per car declined. Since 1891 the yearly passenger traffic per car has steadily increased.

A strong feature of electric, compared with horse, traction, has been the saving of human labor. In 1888 the street railways had 5,531 employés, and in 1900 the number was 12,766. While main tracks had their length increased 3.5 times, while the car-miles of operation went up 3.5 times and while the passenger traffic was multiplied 2.93 times, the number of employés advanced only 2.3 times.

EMPLOYEES OF STREET RAILWAYS.

Year of Sept. 30.	Number of Employés.	Number of Passengers per Employé.
1888	5,531	24,313
1889	6,302	23,514
1890	6,246	26,396
1891	6,449	27,305
1892	7,185	27,024
1893	8,070	26,462
1894	7,451	29,588
1895	8,048	32,280
1896	9,130	32,021
1897	9,716	31,770
1898	10,416	31,767
1899	11,944	29,866
1900	12,766	30,943

In 1888 the street railways had one employé for every 24,313 passengers carried, by 1896 the employés numbered one for every 32,280 passengers, but this went down to one to 30,943 in 1900.

Great as has been the physical development of street railways since the introduction of electric motive power, it has been exceeded by their attendant financial expansion. For September 30, 1888, the total investment in horse railways, including the short experimental road at Revere, was $17,237,100, measured by capital stock and net debt. On the like date for 1900 this investment stood at $84,715,097. This later number is 4.9 times the former and represents a greater increase than that of track length, cars, car-miles, round trips or passengers. The amount added to street railway investments since 1888 is thus $67,477,997, which is equivalent to an average of $5,622,249 yearly.

CAPITAL INVESTMENT OF STREET RAILWAYS.

Year of Sept. 30.	Total Investment.	Investment per Mile—Main Track.
1888	$17,237,100	$32,304
1889	19,418,098	33,907
1890	23,427,103	38,256
1891	27,497,604	40,890
1892	34,862,324	46,184
1893	46,050,678	53,367
1894	49,104,408	52,963
1895	52,928,931	49,120
1896	59,206,063	46,373
1897	63,112,764	44,683
1898	68,757,764	44,958
1899	77,226,214	45,040
1900	84,715,097	44,273

The year of greatest increase was that ending September 30, 1893, which saw $11,118,354 added to street railway investments throughout the state. Next in point of added investment was the year of 1889, when street railways absorbed $8,468,450.

In spite of this remarkable expansion, the gross earnings from operation of street railways have increased at only a moderately less rate than the investments, while net earnings have actually surpassed them. For 1898 the horse car systems received $6,824,317 from operation, and in 1900 the corresponding figures were $19,999,640, or 2.9 times the earnings of the earlier year. Net earnings made a greater rise, from $1,291,250 in 1888 to $6,839,693 in 1900, an expansion to 5.3 times the former amount. This result for net earnings has been achieved through the superior economy of operation with electric traction, as well as through the improved public service rendered. While gross and net earnings have been going up, the ratio of operating expenses to earnings has been going down. With horse traction in 1888, operating expenses were 81.07 per cent of gross earnings. Electric power in 1900 had reduced the expenses of operation to 65.80 per cent of gross earnings. This reduction was neither constant nor uniform throughout the period. For the fiscal years of 1893, 1894 and 1895, the ratios of operating expenses to gross earnings stood at 69.26, 69.51 and 68.93 per cent respectively.

The great extension of street railways by which 348 miles of new main track was added in 1895 and 1896, tended to increase operating expenses at a more rapid rate than gross earnings.

GROSS AND NET EARNINGS OF STREET RAILWAYS.

Year of Sept. 30.	Gross Earnings from Operation.	Per Cent of Expenses to Earnings.	Net Earnings.
1888	$6,824,317	81.07	$1,291,520
1889	7,523,575	78.40	1,624,771
1890	8,348,285	74.80	2,104,077
1891	8,861,841	76.13	2,115,537
1892	9,798,060	71.74	2,768,581
1893	10,832,174	69.26	3,330,329
1894	11,119,846	69.51	3,390,787
1895	13,184,342	68.93	4,096,256
1896	14,844,262	71.16	4,280,891
1897	15,815,267	68.95	4,911,227
1898	16,915,405	69.01	5,242,674
1899	18,151,550	68.20	5,773,062
1900	19,999,640	65.80	6,839,693

In 1896 the operating expenses were 71.16 per cent of gross earnings, but by 1900 they again fell to 65.8 per cent. Cents of net earnings per car-mile went up from 5.56 in 1888 to 9.35 in 1895, when the great extension of interurban systems that is still in progress set in. In the next year there was a drop to 7.99 cents, and a subsequent recovery to 8.36 in 1900. A large gain is exhibited by the net income per round trip which rose from forty cents in 1888 to eighty-eight cents, or 2.2 times that amount in 1900. This increase is probably due in part to the greater length of round trips in the later years. Between 1888 and 1892, while old horse cars were being rapidly set aside, the net yearly income per car fell from $2,636 to $2,536 in 1891. With the following year an advance on these figures set in and reached $3,062 in 1900.

NET EARNINGS OF STREET RAILWAYS.

Year of Sept. 30.	Cents per Car-Mile.	Cents per Round Trip.	Dollars per Car.	Cents per Passenger.
1888	5.56	40	2,636	0.96
1889	5.27	47	2,557	1.09
1890	7.61	56	2,571	1.27
1891	7.65	54	2,536	1.20
1892	9.32	66	2,675	1.43
1893	9.65	74	2,681	1.56
1894	9.23	73	2,740	1.54
1895	9.38	80	2,978	1.57
1896	7.99	71	3,021	1.47
1897	7.97	75	2,959	1.59
1898	7.69	76	2,950	1.59
1899	7.87	81	3,004	1.62
1900	8.36	88	3,062	1.73

This remarkable showing for electric traction is well summed up in the rise from 0.96 cent in 1888 to 1.73 cents in 1900, or eighty per cent, in the net earnings per passenger.

Motor Starting.

In a paper recently read before the Newcastle Local Section of the Institution of Electrical Engineers, Mr. A. E. Gott deals with the design of starting resistances for motors. Series-wound motors up to two horse-power may, he remarks, be safely started without the use of starting resistances, if the full load is not thrown on until they are well under way, but with all but the very smallest sizes of shunt motors such resistances are necessary. As commonly made, however, these resistances are often, he stated, wrongly divided up, the resistance thrown out at each movement of the switch arm being equal. Under these conditions the rush of excess current through the armature increases regularly with each successive step, and may be very excessive at the final one. The proper method of designing such starting devices should be such that the resistances cut out at each successive movement vary in geometric ratio, the largest resistance being that cut out in the first motion of the switch arm, and the smallest that cut out last.

Safety of Consumers and Grounding of Secondaries.

To the Editor of the Electrical Review:

Since the publication of the Cedar Rapids, Iowa, case, in which the writer and his associate, Mr. G. M. Willis, testified as experts for Swift & Company, many communications have appeared in the electrical papers and the writer has received a number of letters from central station managers and consumers of electric light, asking pertinent questions. Instead of answering these individual enquiries, the writer therefore thought it opportune to give a general outline of the facts and conclusions to be drawn from damage suits. During the last three years the writer has had five times occasion to testify in damage suits; four were fatal cases, and in one case the man was crippled for life. It might be interesting to note that in these five cases which have come to the writer's personal observation, the facts were almost identical, *viz:*

1. In each case the alternate high-potential current passed on to the secondary lines through the faulty insulation between primary and secondary coils of the transformer.

2. In each case the person received the fatal shock by touching a lamp socket.

3. In all cases the accident occurred during a shower or immediately after, when the ground was wet and the man receiving the fatal shock was standing on the wet ground or its equivalent.

4. In all cases other troubles had occurred before the fatal accident had occurred and had been reported by telephone to the central station and they, instead of shutting off at the power station the particular circuit on which there was trouble, sent a lineman or a trouble-man to the consumer's premises to investigate and in each case this man was too late in disconnecting the wires leading to the consumer and the fatal accident occurred shortly before his arrival.

5. In each of the five cases the plaintiff claims that the accident occurred because of faulty insulation of the secondary wires or sockets and that if the consumer had seen to good insulation the accident could not have occurred.

6. In four cases the plaintiff was the widow of the injured person.

7. In three cases the injured persons were employés of the consumer, in one case the injured party was employed by the electric lighting company, and in one case (Swift & Company) the person killed was a customer of the consumer.

8. In each of these five cases the plaintiff brought a joint suit or two individual suits against both the consumer on whose premises the accident occurred, and against the electric lighting company.

9. In each of these five cases the electric light company tried to throw the burden on the consumer.

10. Four of these cases were fought out in court; one was settled by compromise. The four cases were decided in favor of the plaintiff, three cases against the electric light company and one against the consumer (Swift & Company).

It would really be carrying coals to Newcastle should I expound the well-known principles underlying such occurrences, and it seems to me, in order to be concise, that I should repeat *verbatim* a paper read by Dr. Cary T. Hutchinson before the American Institute of Electrical Engineers, Boston, June 25, 1899, entitled "The Protection of Secondary Circuits from Fire Risks" (see transactions of the American Institute of Electrical Engineers, 1900). In order to recall to the reader some of the many points of this paper and of the discussion following the reading of the paper I cite the following:

Dr. Hutchinson, speaking of the advantages of permanently grounding the secondary of low-potential circuits, says:

It would seem that a remedy as simple as this—one generally applicable—would have been applied in all cases, but the fact is that it has attained a limited use only. The reason for this state of affairs is the refusal of the Board of Fire Underwriters to authorize the practice of grounding any part of a circuit carrying current. The underwriters take the position that to ground one side of a circuit brings about an increased liability to fire, because the full voltage of the circuit continually acts upon the insulation of the circuit, instead of one-half of this voltage, as in an insulated system, and because one accidental ground on the insulated side may cause a fire.

At the end of his paper Dr. Hutchinson offers the following resolutions:

Resolved, That the American Institute of Electrical Engineers favors a rule permitting the grounding of one wire of every low-potential consumption system.

Resolved, That the Committee of the American Institute of Electrical Engineers on the National Electrical Code is hereby requested to confer with the Electrical Committee of the Underwriters' National Electric Association in relation to recommending to the National Board of Fire Underwriters the passage of a rule permitting or requiring the permanent grounding of one wire of such systems, under suitable restrictions.

In the discussion following the reading of the paper Professor Elihu Thomson, in referring to the invention of the film cutout, says:

Now the actual state of the case is this: That the wiring in my former house at Lynn—I think the plant was installed about 1887—had its secondary grounded. I grounded on gas and water pipes and preferred that arrangement to any other.

Mr. Steinmetz says:

There has been in the last few years a great deal of discussion as to whether the grounding of the secondary is safer regarding fire risk or not, and the majority of opinions seems to be strongly in favor of grounding.

Regarding danger to life, however, there never has been any doubt, and never can be, that the only absolute and perfect protection against danger to life in case of an accidental contact of the lighting circuit with a high-tension circuit of any description, is a permanent and absolute ground of the low-tension circuit.

I should certainly hesitate—when standing, for instance, on the damp floor of a cellar—to turn on an incandescent lamp when knowing that the only protection against certain death is the insulation of some unknown type of transformer which hangs somewhere on a pole, exposed to the weather for years. The film cutout as a protective device is certainly better than nothing, and there may be people who would enjoy getting into a 3,000-volt circuit if they knew that a film cutout will probably open the circuit quickly, but I myself should decline to do so.

Captain William Brophy, inspector for the fire underwriters, says:

In New England there have been but two lives lost since the introduction of the alternating system, due to the breaking down of the insulation of transformers, one in Boston, the other in Woburn. There has been some criticism of the underwriters indulged in which I think is unjust. The station manager is apt to throw the burden that belongs to himself onto the shoulders of the underwriters' inspectors. He owes it to his company and to its patrons to see that the most approved form of electrical work is done, and the best material used.

He injures the business not only of his company but of every other one throughout the country when he countenances slipshod methods of electrical construction.

Dr. Kennelly, who was presiding at the meeting, stated:

I do not know any man conversant with the facts who would let any person, for whose life or safety he was responsible, go into a damp cellar and touch any part of a secondary circuit when there was a high pressure turned on on the primary side. I want to see the man who would permit any child of his to do that thing unless adequate precautions were taken for protecting the secondary circuit.

After the presentation of certain amendments, the resolutions offered by

Dr. Hutchinson were passed in the form in which they are cited above. This, I repeat again, was in 1899. Since then the underwriters yielded and in 1900 they inserted paragraph "13A, Grounding Low-Potential Circuits" in their code:

The grounding of low-potential circuits under the following regulations is only allowed when such circuits are so arranged that under normal conditions of service there will be no passage of current over the ground wire.

Direct-current three-wire systems:

(*a*) Neutral wire may be grounded, and when grounded the following rules must be complied with:

1. Must be grounded at the central station on a metal plate buried in coke beneath permanent moisture level, and also through all available underground water and gas-pipe systems.

2. In underground systems the neutral wire must also be grounded at each distributing box through the box.

3. In overhead systems the neutral wire must be grounded every 500 feet, as provided in sections *c, e, f* and *g*.

Inspection departments having jurisdiction may require grounding, if they deem it necessary.

Two-wire direct-current systems having no accessible neutral point are not to be grounded.

Alternating-current secondary systems:

(*b*) The neutral point of transformers or the neutral wire of distributing systems may be grounded, and when grounded the following rules must be complied with:

1. Transformers feeding two-wire systems must be grounded at the centre of the secondary coils, as provided in sections *d, e, f* and *g*.

2. Transformers feeding systems with a neutral wire must have the neutral wire grounded, as provided in sections *d, e, f* and *g*, at the transformer, and at least every 250 feet for overhead systems and every 500 feet for underground systems.

Inspection departments having jurisdiction may require grounding if they deem it necessary.

Following this the underwriters give implicit instructions as to how the grounding connections are to be made. In this connection particular attention is also drawn to paragraph 62 of the "National Electrical Code," which stipulates in detail the tests which transformers must stand in the factories before they are shipped. As to the installation of the transformers, the rule states that when heated they shall withstand continuously for five minutes a difference of potential of 10,000 volts alternating between primary and secondary coils and between the primary coils and core, and at a no-load "run" at double voltage for thirty minutes.

I think that the above answers all the enquiries which I have received, and there certainly does not seem to be any excuse for station managers disregarding these rules when they know that the lives of their consumers are jeopardized, as the high potential can come into the houses of the unsuspecting consumers at any time, not only by means of leaks in the transformer, but in many other ways, as, for instance, by contact of foreign wires carrying high-potential currents with the secondary wires. The conclusions to be drawn from the above seem very plain:

1. The fire underwriters, from a straight business point of view, are naturally only interested in fire risks and not in the injuries to human beings; for that reason they do not make the grounding of the secondary compulsory, but only permit it, and it seems to be the duty of the city inspector to have issued city ordinances making the grounding of the secondary compulsory for the absolute protection of human life. All consumers of electric current should join in such a movement for their mutual protection.

2. The central station managers should realize that they—and they alone—are responsible for any accidents that befall their consumers, and for this reason should be the most interested parties in enforcing the permanent grounding of the secondaries.

In one of the letters received the station manager says that his company could not afford to throw away all its transformers and he could not comply with the underwriters' rules to ground the centre of the secondary coils, as his transformers were not built in that manner. To this I want to say in answer that I should recommend the banking of two transformers in series, both, of course, to be of the same manufacture, type and capacity, thus supplying his consumers with light on a three-wire system. This will have the advantages of making the system absolutely safe (grounding the neutral), using his old transformers until they give out without endangering his consumers, reducing the loss in the service wires and getting a better distribution and more uniform potential generally. Any transformer put up on a pole, exposed to wind and weather, no matter how well built and how well tested, will give out in the course of time and it is well for the station manager to know when it has given out. When it does give out there will be no injuries to anybody and no fatal accidents can occur, because the high potential passing from the primary to the secondary wires will at once be relieved through the earth connection. As a matter of fact there does not seem any excuse at all for fatal accidents occurring from high-potential currents getting into the low-potential circuits of the consumers, if the manager of the central station is competent and aware of the responsibility that rests on him solely as to the protection of the life of his consumers.

F. B. BADT.

Chicago, February 1.

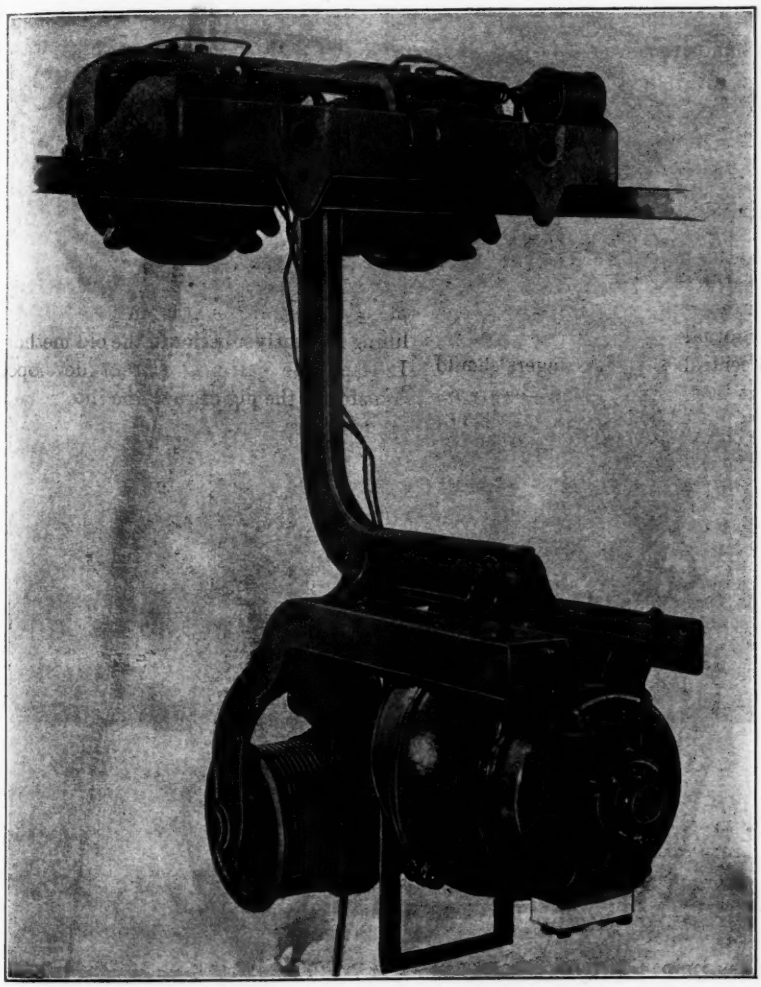
Galvanic Current in Cleaning Boilers.

The following translation of an article which recently appeared in *Rivista Minera Metalurgica y de Ingeneria*, of Madrid, the leading journal of its kind in Spain, as of possible interest to our manufacturers and engineers, was sent by United States Consul Ridgely, of Malaga: The use of zinc to prevent the oxidation of the iron and the incrustation in steam boilers has greatly increased during recent years. Heretofore, zinc has been employed for this purpose only in the shape of raw pigs, but after many experiments made by the society of "Mines et Fonderies de Zinc de la Vieille Montagne," which have since been confirmed by the British Admiralty, by the national French marine, and many great maritime companies, it has been established that compressed laminated zinc made in the form of thick plates for application as an inside boiler lining is greatly superior to the old method. In fact, the galvanic current developed transforms the pig of raw zinc into a more porous substance, in which the metallic molecules are isolated one from the other by the corrosion which is quickly produced, resulting in this, that the intimate metallic contact, which causes the generation of the electric current, is eliminated. Compressed laminated zinc, on the contrary, resists the spongy internal corrosion, as it corrodes only on the surface, thus being very slowly consumed and being capable of conducting the current as long as a metallic nucleus remains. The application of the laminated plates is very simple. They are applied to the walls of the boilers by means of strips, and are so distributed that the galvanic action is exercised in an even way, when possible, over the entire surface of the iron. When oxidation is produced in any part of the boiler, it is because the nearest zinc plate is too far away. By this employment of pressed zinc the incrustation of the boilers is avoided, and at small cost.

The bulletin of the American Iron and Steel Association says: The total production of pig iron in 1901 was 15,878,354 gross tons, against 13,789,242 tons in 1900, 13,620,703 tons in 1899, 11,773,934 tons in 1898 and 9,652,680 tons in 1897. The increase in 1901 over 1900 is larger than the boom year, 1899, shows over the year 1898. Stocks of pig iron unsold in the hands of manufacturers at the close of 1901 amounted to only 70,647 tons, against 442,370 tons at the close of 1900 and 372,560 tons on June 30, 1901. The number of furnaces in blast on December 1, 1901, was 266, against 232 on December 31, 1901, and 259 on June 30, 1901.

Electric Hoists for a Telpherage System.

Some interesting auxiliary apparatus for use in connection with the telpherage system of handling materials has recently been devised. The accompanying illustration gives an excellent view of a high-speed electric hoist adapted for use with the system of the United Telpherage Company, New York.



An Electric Hoist for a Telpherage System.

As is well known, the telpherage system consists of an overhead cable-way or rail upon which an electrically driven truck moves, carrying, suspended below, its load. This hoisting apparatus is intended to be hung from the telpher, as the illustration shows. The machine can also be suspended below a trailer running on the overhead cable, if this is desirable.

The general construction of the hoists is easily understood by reference to the illustration which shows it with the casings removed. The gears are of cut steel and run in oil, the various thrusts being taken up by ball bearings. The double-drum construction, the advantages of which are well understood, is utilized, and throughout the design of the machine simplicity has been carefully sought. The result is the production of an appliance having few moving parts and great accessibility of all portions liable to wear.

The motors are iron-clad, dustproof and fireproof, and are intended for rough and ready direct hoisting service. They are wound for the standard voltages of direct current and are constructed in any suitable capacity.

The uses of the telpherage system are widely increasing, it having come into very wide use in machine shops, foundries, factories, mills and other places where it is desirable to move heavy objects about without encumbering the floor with tramway tracks which must be kept clear.

Of the telegraphic poles set up at Fengtai and Chunghsiang in Chili by the Japanese after the capture of Peking by the allies, more than thirty at the former place and no less than ten at the latter place have been wantonly cut off or otherwise destroyed by the natives.

Electric Light Plants in Nicaragua.

Consul Chester Donaldson writes from Managua that the government of Nicaragua has granted to Mr. T. M. Solomon, an American citizen, and Mr. J. Santos Ramírez, a Nicaraguan, a concession for installing electric light systems at Managua, Masaya, Granada, and Leon.

Managua is to be the first city lighted. The motive power is to be steam. Meanwhile, the concessionnaires will construct a dam to utilize the water power of Tipitapa Falls, where a plant sufficient to supply the needs of the first three cities will be erected. The steam plant at Managua will then be moved to Leon.

It has been decided that by constructing a dam about five feet high at the edge of Tipitapa Falls, Lake Managua (of which the Tipitapa River is the outlet) can be maintained at a sufficiently high level to always give an ample supply of water for the power required. Mr. Warren B. Reed, the concessionnaires' electrical engineer, calculates that by raising the lake one foot more than its annual evaporation, about 20,000,000,000 cubic feet of water will be secured; and that by placing the power-house about 500 yards below the falls, at the foot of the rapids, a fall of eighteen feet will be obtained, which will give sufficient power to run the plant for four consecutive years, even if there should be no rain during that time.

The government has also granted Messrs. Solomon & Ramírez exemption from import duties on all materials to be used in the enterprise and on provisions and clothing for their employés.

The contract provides the following rates for each light installed:

DESCRIPTION.	RATE.	
	Pesos.	
One 16-candle-power.....	6.50	*$1.85
1 button and switch.....	3.00	.85
100 feet of wire.....	18.50	5.28
Monthly charge.....	3.00	.85

Bids are being received for the posts, and machinery has already been ordered from the United States.

The plant is to be in working order within six months from date.

Professor Charles Wilson has announced to the Royal Society a new determination of the temperature of the sun, which, with due allowance for slight unavoidable errors, is placed at 6,200 degrees centigrade (11,192 Fahrenheit). If the probable absorption of the sun's radiated heat by its own atmosphere is allowed for, the mean temperature of the sun's body is placed at 6,600 degrees centigrade. Professor Wilson started his calculations almost ten years ago.

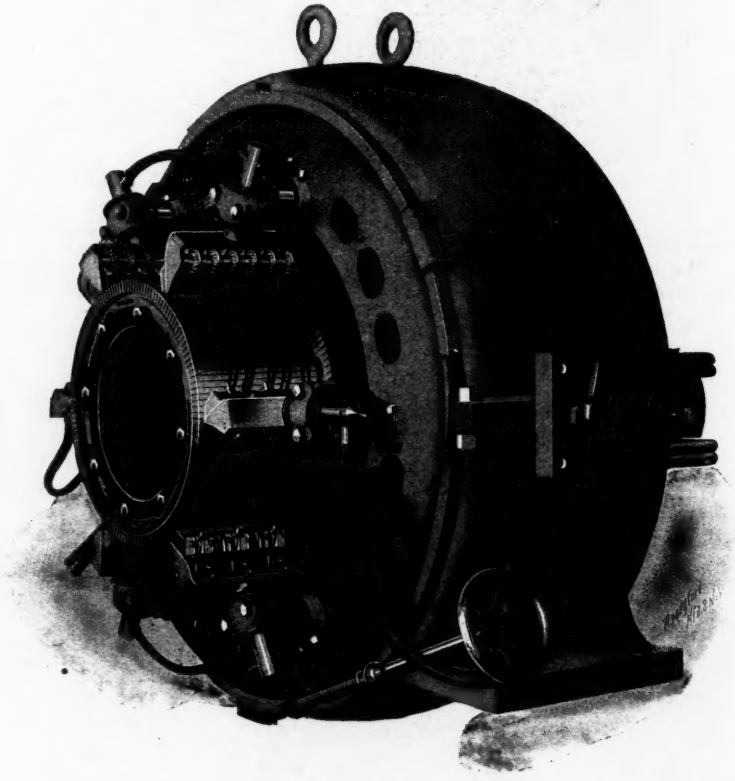
* Value in United States gold at present rate of exchange.

An Engine-Type Direct-Current Dynamo.

It has come to be very generally recognized in the last few years that the antiquated method of transmitting power from an engine to the various parts of a works or factory must give way to the new method, employing electric motors and wires in place of belts and shafting. To the solution of the interesting problem presented by power transmission in factories, the Eddy Electric Manufacturing Company, of Windsor, Ct., has given much attention. The accompanying illustration exhibits a type of dynamo adapted for direct-coupling with an engine for this purpose, or for electric lighting or other uses to which a direct-current generator may be put.

The field frame of the machine, as the illustration shows, is made of two castings, the upper one being removable in case it is necessary to get at the armature. The brush-holder frame is exceedingly massive and rigid in construction, its general method of application being better shown by the illustration than by any description. Attention is directed to the relatively large commutator and the great bearing surface of the brushes. The illustration shows a six-pole type, though machines of smaller size are constructed in a four-pole type, and larger machines in types having a greater number of poles and adapted to the slower revolution speeds of large engines.

These machines are wound throughout with formed coils, the armatures being very deeply slotted and the coils locked in by a method which secures great mechanical strength and at the same time permits easy removal of a coil in case repair is necessary.



SIX-POLE ENGINE-TYPE GENERATOR.

Injury to the Eye Caused by Intense Light.

There may be some general interest in the following case of optical phenomena brought about by exposure of the eye to intense light.

Professor M., while working in a rather dark corner of his laboratory, writes Frank Allen in *Science,* accidentally broke a low-resistance circuit in which an electric current at a pressure of 500 volts was flowing. The arc formed was about a foot from his eyes and appeared like a ball of fire rather more than six inches in diameter. Immediately there was a feeling that something had "given way" in his right eye, though no pain was experienced. Shortly afterward he noticed that a part of the retina was permanently affected, the injured portion being in the form of a square, with the centre of vision in one corner. The sharp outlines of this field could be easily distinguished, and upon closing the eye, fan-shaped flashes of a violet color spread out from one corner over the injured area at equal intervals of several seconds, their recurrence being entirely involuntary. After being some time in the dark the flashes of color ceased.

There was in general an apparent lack of illumination over this part of the retina, accompanied by a loss of power to properly distinguish colors, more especially green. The outlines of objects were blurred, their dimensions also appearing to be reduced by about one quarter. Printed letters could not be recognized at more than half the distance at which they were easily read by the uninjured eye. Parallel lines seemed to converge over the injured portion. In walking and riding he noticed at a short distance ahead what seemed to be a spot a few inches in diameter and about two inches high, which he often turned his wheel aside to avoid. The injured eye was also very defective in estimating distances. The effect lasted several weeks with almost undiminished intensity, but has since been gradually disappearing.

Magnetic Brakes for Amsterdam.

A serious accident, involving the wrecking of two electric cars on the Market street line of the Amsterdam, N. Y., Street Railway Company recently, led the management to make a careful examination of the brake systems now employed for street railway service. As a result of this investigation the magnetic brake of the Standard Traction Brake Company was selected, and, after thorough tests under the most difficult conditions and in the most exacting service, it was finally adopted for the entire system. Car No. 15, one of those which was in the wreck, was entirely rebuilt and fitted with magnetic brake equipment. The first public demonstration was given recently when a trial trip was made over the line. The car was taken up Market hill and allowed to descend, the operation being watched with considerable interest by many pedestrians as well as those on board. The magnetic system proved excellent under the most adverse conditions, the motorman being able to bring the car to a full stop on any portion of the grade in less than a car's length, notwithstanding that the track was muddy and slippery because of falling snow. The car was gotten under full headway and stopped short repeatedly, the brakes fulfilling every requirement.

CURRENT ELECTRICAL NEWS

COMMERCIAL NEWS

DOMESTIC AND EXPORT

ELECTRICAL TUNNEL ROAD—The Union Terminal Company, of New York, was incorporated with the Secretary of State, at Albany, with a capital of $100,000, to construct and operate an electrical tunnel road between nine and ten miles long between New York and Kings counties.

PLANS VAST TROLLEY SYSTEM—A despatch from Indiana states that an organization is under way to promote an electric system which is to connect the cities by January 1, 1903. This enterprise is backed by New York, Ohio and Michigan capitalists, and much of the money will be supplied by Senator Depew.

NEW BRIDGE COMPANY—American capital is to be employed to build a bridge across the St. Lawrence for entrance into Montreal. It will be built by the Atlas Construction Company, the latter company having been organized recently in New Jersey for the express purpose of building this new Canadian bridge. The new bridge will be 8,800 feet long and the main span, a cantilever of 1,260 feet, will be the longest of its kind on the continent. The structure will accommodate two steam railway tracks, two electric car tracks, a double highway and two sidewalks.

TROLLEY COMPANY MAKES GOOD REPORT—The annual report of the Capital Traction Company, of Washington, D. C., as recently submitted, shows that the passenger earnings were $1,228,072, an increase for the year of $91,398. Total earnings from operation were $1,231,683, and operating expenses were $560,171, or 45.6 per cent. Net income from all sources was $579,389, and after paying four per cent dividend on the $12,000,000 stock there was a balance of $99,389. There were carried during the year 28,362,565 passengers, or an average of 77,700 a day.

ELECTRIC RAILWAY IN THE PHILIPPINES—The Luzon Transportation and Improvement Company, of which J. H. Culver, of Sutton, Neb., is the president, is reported to have been recently organized for the purpose of building an electric railway between Subig and Manila Bay, Philippine Islands. The road will be about twenty-five miles long. It is said that the route is covered with valuable timber and that the road will open up a rich agricultural region. It is expected to utilize water power to generate the necessary electrical energy. Contracts for the equipment, etc., will be let in the spring.

BRITISH CAPITAL FOR NEW TROLLEYS—A proposal for the extension of the Aberdeen tramways has lately been under the consideration of the tramway committee of that Scotch city, with the result that it has been decided, subject to the approval of the council, that the overhead trolley system be introduced on the proposed additional route, at an estimated cost of $180,000. At a special meeting of the West Brunswick (England) town council it was decided to draw a check for $160,000 for the purchase of the South Staffordshire Tramways, and also to pay $27,500 to the Birmingham & Midland Tramways for the acquisition of that property within the borough. It was further resolved that application be made to the British Board of Trade for sanction to borrow some $600,000, the money necessary to carry out the reconstruction and electrification of these lines.

LEGAL NOTES

NEGLIGENCE OF LOOKOUT—A railroad company is held in Mason *vs.* Southern R. Co. (S. C.) 53 L. R. A. 913, to be liable for causing the death of an infant upon its tracks, if the direct and proximate cause of the accident was negligence in failing to keep a reasonable lookout, and to discover the child in time to have prevented the injury.

INTERRUPTED TRANSMISSION OF TELEGRAM—Transmission of a telegram at a time when a storm has made the wires to work badly is held in Coit *vs.* Western Union Telegraph Company (Cal.) 53 L. R. A. 678, not to be gross negligence, if, when it is actually sent the wires are in good working order, and the statute requires the forwarding of messages at the earliest practicable moment.

LIABILITY OF A TELEGRAPH COMPANY—In the case between the Commonwealth and the Western Union Telegraph Company, which grew out of an indictment charging the company with unlawfully maintaining a common nuisance in furnishing a Louisville poolroom information about horse races, and unlawfully enabling the patrons to bet on the results of races, Chief Justice Painter has held that a telegraph company is not liable for transmitting a message to gambling places, and in no wise responsible for the uses to which information transmitted over its lines is put. Justice Painter held, in construing the statute, that a telegraph company's position toward the public is like that of a railroad company and other common carriers. It was his opinion that the fact that persons who received the information from the telegraph company and as a result of it were guilty of unlawful practice did not make the company responsible.

TELEPHONE AND TELEGRAPH

BEAVER, OHIO—A company is being organized to furnish Beaver township with telephone service.

WASHINGTON, PA.—The borough council has granted a right of way to the West Penn Telephone Company.

TOLEDO, OHIO—The Central Union Telephone Company has purchased the plant of the Harrison Telephone Company.

UTICA, N. Y.—The Utica Telephone Company has been granted a franchise to do a telephone business within the limits of the city.

FORT WAYNE, IND.—The Delaware-Madison Counties Telephone and Telegraph Company has been organized with a capital of $500,000.

HARRISBURG, PA.—The United Telegraph and Telephone Company has secured control of the Cumberland Valley Telegraph and Telephone Company.

MARION, IND.—The Fairmount Telephone Company, including all toll lines, has been purchased by the United Telephone Company, the deal taking effect recently.

ITHACA, N. Y.—Superintendent of Construction, E. F. Chapman, of Elmira, is installing the system of the new Ithaca Telephone Company; a force of forty men being engaged.

BATH, N. Y.—The Bath & Addison Telephone Company is setting poles preparatory to extending a spur from Thurston to this place. This will result in increased telephone service.

SPRINGFIELD, ILL.—D. R. Craig, constructing engineer of the Northwestern Telephone Company, has begun preliminary work upon the construction of a second telephone system in this city under the franchise recently granted by the city council.

CYNTHIANA, KY.—The threatened telephone war in Cynthiana, between the Cumberland or East Tennessee Telephone Company and the local independent company, has been averted and a compromise effected whereby Cynthiana will have improved telephone service.

DETROIT, MICH.—The Cooperative Telephone Company has been organized and capitalized at $250,000 for the purpose of establishing an independent telephone system. The officers are F. F. Ingram, president; Hamilton Carhart, vice-president; Wilbur Brotherton, secretary; C. M. Burton, treasurer.

BALSTON, N. Y.—A mortgage for $150,000 executed by the Waterford-Cohoes Home Telephone Company, to the Knickerbocker Trust Company, of New York, was recorded recently in the Saratoga County Clerk's office. The mortgage was made to protect an issue of 100 bonds of $1,000 each and 100 of $500 each, payable in gold on January 1, 1927.

LEAVENWORTH, KAN.—Arrangements have been made between the McLouth and Tonganoxie telephone companies for joining lines at Jarbalo. About half the distance has already been constructed between McLouth and Jarbalo, and between Tonganoxie and Jarbalo. A junction at Jarbalo will give Tonganoxie telephonic connection with most of the towns in Jackson and Jefferson counties.

BOSTON, MASS.—The American Telephone Company made net addition of 58,044 telephones in licensees hands under rental in December, against 39,603 in the same month of 1900. Total additions for the year 1901 were 573,194, against 372,311 in 1900, the total outstanding December 20 was 2,526,010, against 1,952,816 end of 1900. The number of telephones in use has more than doubled since end of 1898.

ELECTRIC RAILWAYS

HARTFORD, CT.—A new line is being promoted from Providence, R. I., to Worcester, Mass.

BUFFALO, N. Y.—Work is about to be commenced on the double-track road between Buffalo and Rochester.

SPRINGFIELD, OHIO—The preliminary survey for the new electric line to South Charleston is now being made.

ST. LOUIS, MO.—The Municipal Railroad Company has asked for a franchise to operate through eighty miles of streets.

LOGANSPORT, IND.—The Logansport Street Railway Company and the Kokomo Street Railway Company have been consolidated.

WESTFIELD, MASS.—Capital stock to the amount of $300,000 has been taken up to build a trolley line from Westfield to Lee.

MOUNDSVILLE, W. VA.—The city council has granted to the Citizens' Street Railway Company a franchise for its belt line over the city.

SYRACUSE, N. Y.—As soon as consents and franchises are secured the Syracuse Rapid Transit Company will build a line to Liverpool, N. Y.

LEBANON, IND.—An ordinance granting a franchise to the Indianapolis & Lebanon Traction Company has been passed by the city council.

PHILADELPHIA, PA.—Plans are nearly completed for the new Market street line, and Mr. J. M. Mack states that he will shortly begin construction.

CAYUGA, IND.—The Danville Street Railway and Light Company will extend its line from Danville to Catlin, a distance of seven miles, in the spring.

ELMIRA, N. Y.—Permission to construct a trolley line between Waverly and Elmira has been given to the Elmira & Waverly Electric Railroad Company.

FREDONIA, N. Y.—The village trustees have granted a ninety-nine-year franchise to the Lake Shore Traction Company to run through on East Main street.

ATLANTIC CITY, N. J.—An effort is being made by the Delaware River & Atlantic City Railway Company to build a trolley line between Gloucester and this city.

BATTLE CREEK, MICH.—The Gordon Traction Company, which is promoting the electric line between this city and Lansing, has asked for a franchise to enter the city.

EVANSVILLE, IND.—The Evansville & Mt. Vernon Traction Company is busily engaged in the preliminary work of building its electric line from Evansville to Mt. Vernon.

WINCHESTER, IND.—A forty-year franchise for a line to connect those of the Union Traction Company with Dayton & Northern has been granted, and work will begin at once.

YONKERS, N. Y.—A resolution has been presented to the common council allowing the Union Railway Company to have more time to extend its lines to Tuckahoe and New York city.

WAUSAU, WIS.—Several outside men of capital are negotiating with the people of the towns between this city and Merrill, with a view of securing a right of way for an electric railway.

SALINA, KAN.—An electric railroad from Salina north to Lincoln, Kan., is a matter that is receiving the attention of the Salina Commercial Club. The proposed route is thirty-five miles in length.

EDWARDSVILLE, ILL.—The Illinois Valley Traction Company proposes to connect Ottawa, in La Salle County, and Princeton, in Bureau County, and the various towns intermediate with an interurban electric road.

UTICA, N. Y.—At a recent meeting of the stockholders of the Utica & Mohawk Valley Electric Railroad, it was voted to increase the capital stock from $461,237 to $3,100,000, of which $600,000 is preferred stock.

VINCENNES, IND.—The county commissioners have granted a franchise to Elmore F. Cox, of Greene County, F. E. Chappell, J. W. Wilson, H. R. Snyder and Sol Frank, of Petersburg, Ind., to build an interurban electric railroad from Vincennes to Jasper, Dubois County, Ind.

WAXAHACHIE, TEX.—At a recent meeting of the city council an ordinance was adopted granting a franchise to A. T. Byars and associates to enter and operate a trolley line in this city, being the Waxahachie terminus of the projected Waxahachie & Ennis trolley line.

JOHNSTOWN, PA.—The details are about all arranged for the purchase of the Connellsville & Suburban Street Railway and the Youghiogheny Light, Heat and Power Company, of Fayette County, by the Pittsburgh, McKeesport & Connellsville Railway Company. The consideration is $175,000.

ELECTRIC LIGHTING

FREMONT, OHIO—The Fremont Gas, Electric and Power Company will rebuild its entire electric plant.

HORNELLSVILLE, N. Y.—The American Illuminating Company is making extensive improvements.

NEW YORK, N. Y.—The Mutual Electric Lighting and Power Company is to erect a ten-story power-house.

TERRE HAUTE, IND.—Interested parties will soon organize a new electric light company, and ask for a franchise.

ATLANTA, GA.—T. J. Harper, city electrician, makes a very favorable report on the electrical condition of the city.

ST. LOUIS, MO.—It is stated that a movement is on foot to combine the Imperial and the Citizens' Electric Light companies.

CIRCLEVILLE, OHIO—A five-year contract for lighting the city has been secured by the Circleville Light and Power Company.

WORCESTER, MASS.—The report of the committee on lighting against the purchase of a municipal electric plant has been accepted.

MENOMONEE FALLS, WIS.—A franchise has been awarded for the construction of plants to supply electric light and telephone service.

PHILADELPHIA, PA.—The Berwick electric light plant has been sold to Robert Adams & Company, and extensive improvements will be made.

NEW PALTZ, N. Y.—The New Paltz Electric Light Company has been incorporated with a capital stock of $20,000, divided into shares of $50 each.

BELLEVILLE, OHIO—It is reported that the municipal electric light plant has run considerably in debt during the first two months of operation.

BUFFALO, N. Y.—Authority has been given by the board of aldermen for the commissioner of public works to advertise for bids for city lighting.

BIRMINGHAM, ALA.—The Birmingham Railway, Light and Power Company will make additions to its power plant, ensuring an increased capacity of fully one-third.

WILLIAMSPORT, PA.—The light and water committee has decided to recommend to the finance committee an addition to the appropriation for lighting the streets this year of $2,000.

ROCHESTER, N. Y.—The first steel for the framework of the new power-house of the Citizens' Light and Power Company has been delivered at the Mill street site, and work will begin at once.

NEW BEDFORD, MASS.—An illuminating contract with the city and the New Bedford Gas and Edison Light Company has been signed, and the work of installing a plant to carry out the contract will be begun at once.

FRANKLIN, PA.—There is contemplated the formation of a new company to be known as the Cooperative Light, Heat and Power Company. The capital will not be less than $50,000, and subscription to stock will be popular.

WELLINGTON, KAN.—The contract for building the electric light plant at Wellington has been awarded to A. M. Patitz, of Milwaukee. The contract calls for the personal superintendency of Patitz or an efficient assistant the entire time the plant is being installed.

BINGHAMTON, N. Y.—Negotiations are nearly completed for the combination of the recently incorporated Binghamton Light, Heat and Power Company and Sands, Buckley and Kane, who have a franchise for commercial lighting and a contract for lighting the streets of the city.

CINCINNATI, OHIO—Details of the transfer of the Wyoming Electric Light, Heating and Power Company, to the Cincinnati Gas and Electric Company have been completed. It is said that about $100,000 will be paid. The Gas and Electric company now has a gas franchise for Wyoming.

WHARTON, TEX.—The county commissioners have granted a franchise to T. C. Gordon and others, the use of certain streets whereon to erect poles to be used for erecting electric light wires. Under the grant the erection of the line must begin within ninety days, otherwise the franchise becomes null and void.

ELECTRICAL SECURITIES

Though there has been a conspicuous absence of public interest lately in the stock market, there is evident a hopeful and cheerful tone in financial circles, and had it not been for uncertainty over a possible adverse decision in the Northern Securities case, a decided stimulus would have been effected. The expectation of an early cessation of hostilities in South Africa, and the favorable monetary situation, owing to the prospect of an almost complete abolition of the war revenue taxes, will also keep up a feeling of confidence.

The bank statement failed to affect the market, although in the final session prices showed a somewhat irregular improvement. The cash gain was larger than estimated, amounting to $7,873,000. There was even a larger increase in loans than looked for, the increase amounting to $19,580,000, while deposits were increased by $26,530,000.

ELECTRICAL SECURITIES FOR WEEK ENDING FEBRUARY 1.

New York:	Closing
Brooklyn R. T.	65¾
Con. Gas	217
Gen. Elec.	280
Man. El.	135½
Met. St. Ry.	171¾
Kings Co. Elec.	185
N. Y. & N. J. Tel. Co.	169
Telep., Tel. & Cbl. Co.	5

The earnings of the Brooklyn Rapid Transit Company continue to show good results. The new bridge commissioner has given up his attempt to force the railroad company and ferry company to reduce their fare, as impracticable.

Boston:	Closing.
Am. Telep. & Tel.	159
Edison Elec.	260
Erie Tel. Trust Receipts	21
New England Tel.	145
Mass. Elec. pf.	92
Westing. Mfg. pf.	90

The Boston Stock Exchange has listed upon the unlisted department the receipts of the National Shawmut Bank for $10,000,000 Western Telephone and Telegraph Company five per cent bonds, due 1932, interest payable January and July.

Philadelphia:	Closing.
Elec. Co. of America	6
Philadelphia Elec.	3½
Union Traction	35¼
United G. I. Co.	101½
Elec. Stor. Bat. c	58
Elec. Stor. Bat. pf.	58

The market was quiet. There was quiet buying of Philadelphia Electric 4s and Electric and People 4s during the week.

Chicago:	Closing.
Central Union Tel.	40
Chicago Edison Light	165
Chicago Telep.	185
Metropolitan El. pf.	91½
National Carbon	19
National Carbon pf.	84
Union Traction	11½
Union Traction pf.	47½

Metropolitan Elevated for the month of January carried 98,029 passengers daily, an increase of 8,330.

NEW INCORPORATIONS

YORK, PA.—Wrightsville Light and Power Company. $20,000.

AUSTIN, TEX.—Dublin Light and Power Company, Dublin. $20,000.

CLEVELAND, OHIO—The Cuyahoga Contracting Company. $10,000.

CHICAGO, ILL.—Dahlgren People's Telephone Company, Dahlgren. $2,500.

GUTHRIE, OKLA.—The El Reno Light and Power Company, El Reno. $150,000.

SPRINGFIELD, ILL.—Atlanta Electric Light and Power Company, Atlanta. $10,000.

INDIANAPOLIS, IND.—The Indiana Central Telephone Company, Kirksville. $10,000.

SATER, OHIO—The New Baltimore & Venice Telephone and Telegraph Company. $5,000.

COLUMBUS, OHIO — Salineville Electric Light, Heat and Power Company, Salineville. $15,000.

BRYAN, TEX.—Bryan Telephone Company. $5,000. Incorporators: J. S. Ford, H. M. Aubrey and others.

SAUK CITY, WIS.—Big Hollow Telephone Company. $15,000. Incorporators: M. Sanson, H. J. Ellepson and others.

FORT WORTH, TEX.—The North Texas Traction Company. Increased its capital stock from $2,000,000 to $2,500,000.

INDIANAPOLIS, IND.—The Richmond Automobile and Cycle Company. $10,000. Incorporators: C. F. and M. J. Wright and others.

MADISON, WIS.—The Eau Claire, Chippewa Falls & Northwestern Railway Company; $50,000. The Citizens' Gas and Electric Company; $200,000.

FRANKFORT, KY.—Winchester Railway, Light and Ice Company. $100,000. Incorporators: J. M. Pickell, A. A. Hollenrock and E. S. Jouett.

WOONSOCKET, S. D.—Woonsocket Electric Light, Heating and Power Company. $25,000. Incorporators: Noah Keller, S. A. Ramsay and others.

JERSEY CITY, N. J.—Cuban Telephone and Telegraph Company. $2,000,000. Incorporators: Francis C. Prest, William J. Patterson and others.

KANSAS CITY, MO.—People's Telephone Company. $50,000, all paid up. Incorporators: Henry Wood, John Enoch, Charles B. Stark and others.

RALEIGH, N. C.—The Hamlet & Rockingham Street Railway Company. $150,000. Incorporators: M. C. Freeman, J. P. Cameron and Geo. O. Saunders.

ST. LOUIS, MO.—Electrical Construction and Maintenance Company. $20,000, all paid up. Incorporators: V. T. Pennoyer, William H. McLauran and George D. Harris.

DULUTH, MINN.—The Duluth Transfer Railway Company. $500,000. A belt line in and around Duluth. Mr. Paul A. Mitchell is president and treasurer.

JERSEY CITY, N. J.—Rogers Electrical Works Company. $100,000. To manufacture electricity. Incorporators: John C. Henriques, Nathan Silverman and others.

INDIANAPOLIS, IND.—The Globe Telephone Company. $10,000. To operate in Jay, Randolph, Blackford, Delaware, Madison, Wells and Adams counties. Incorporators: T. O. Boyd, C. C. Mills and others.

WHITEHALL, N. Y.—The Cooperant Telephone Company has increased its capital stock from $15,000 to $50,000. The articles of amendment were signed by George L. Clemons and Emmett J. Gray.

CRIPPLE CREEK, COL.—The Colorado Telephone Company. Increased its capital stock from $3,000,000 to $5,000,000. The amended articles were signed by E. B. Giled, vice-president, and Robert D. Hall, secretary.

INDIANAPOLIS, IND. — The Indianapolis, Nashville & Southern Transit Company. $200,000. To build and operate an electric line from Indianapolis to Nashville, Brown County. Incorporators: F. A. Gentle, Dr. G. B. Martin and others.

NEW YORK, N. Y.—The Bristol Gas and Electric Company. To manufacture gas and electricity for illuminating and other purposes. $300,000. Directors: B. L. Dulaney, of Bristol, Tenn., F. B. Pierce and Frank M. Wells and others, of New York city.

ENID, OKLA.—The Magnet Light, Heat and Power Company. $100,000. For twenty years. To own, manufacture, buy, sell and operate machinery devices for producing electric light and power. Incorporators: H. E. Havens, W. S. Whittinghall, M. A. Kelso, J. A. Hill and others, of Enid.

PRESTON, MINN.—Minnesota & Iowa Electric Railway Company. $500,000. To construct an electric railway from Decorah, Iowa, to St. Paul, Minn., and to manufacture, generate and distribute power for electric lights and other purposes. The company proposes to transport passengers, mails, stock, agricultural products and freight of all kinds. Mr. H. R. Wells, of Preston, is president of the new company.

EXETER, N. H.—The New Hampshire Traction Company. $1,000,000 divided into 10,000 shares of $100 each. To undertake, promote, carry on, encourage and facilitate the formation, organization, development and financial operations of manufacturing, power, electric light, gas, street railway, railroad and other private and public corporations, etc. Incorporators: Wallace D. Lowell, Edwin L. Pride, of Boston; Samuel W. Emery, of Portsmouth; Albert E. McReel and Harry S. Stone, of Exeter.

FORT WAYNE, IND.—Fort Wayne & Southern Traction Company; $25,000; to operate street railway lines in Fort Wayne, Bluffton, Hartford City, Muncie, Decatur, Portland, Winchester and Richmond, and connect the cities with an interurban line. The Fort Wayne & Northern Traction Company; $25,000; to operate lines in Auburn, Garrett, Waterloo, Butler, Kendallville, Albion, Ligonier and Goshen, to be connected by an interurban line with Fort Wayne; the company will also operate pleasure and amusement resorts on its line. Directors of the two companies are: William B. McKinley, Samuel R. Nelson, B. R. Stephens, H. E. Davidson and John R. McCulloch.

INDUSTRIAL ITEMS

THE ISAAC H. BLANCHARD COMPANY, manufacturing printer, New York city, has created a unique and useful calendar, having visible the dates of only one week at one time.

D. L. BATES & BROTHER, manufacturers of electric and water fans, present a beautiful calendar photograph which brings out a keen realization of the usefulness of a motor fan.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, is issuing No. 2 of its calendar series of great men of science and engineering, containing a bust picture of Michael Faraday.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., general western agent for Richmondt conduit, states that the sales for this product have been greater during the last month than ever before in the history of the agency.

THE MCGUIRE MANUFACTURING COMPANY, Chicago, calls attention to its new and improved regulating devices for electric motors and generators. A fine descriptive catalogue, containing illustrations, sizes and prices, will be sent on request.

J. P. WILLIAMS & COMPANY, No. 74 Cortlandt street, New York, acts as general agent for the Anderson Tool Company, manufacturer of arm lamps. The company also is agent for other electrical specialties such as fan motors and magnet wires.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., electrical supplies of every description, has issued a new catalogue and price list, canceling all previous issues. The book contains 174 pages, has a comprehensive index, and is tastefully bound in brown, with an illuminated front cover.

WESTINGHOUSE, CHURCH, KERR & COMPANY, New York city, state that their steam-loop and Holly gravity-return system has met with flattering recognition, particularly in England. Some very large orders have been received for plants in the British Isles, Mexico and the United States.

THE NEW YORK CENTRAL RAILROAD, through its publication department, issues No. 5 of the "Four-Track Series," entitled "America's Winter Resorts," containing maps, descriptions and rates of transportation. This comprehensive pamphlet may be had of Mr. George H. Daniels, general passenger agent, New York city.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., manufacturer of the "chloride accumulator," is issuing in pamphlet form, a treatise on "The Distribution of Electrical Energy in Large Cities," by Louis A. Ferguson, a paper recently read before the American Institute of Electrical Engineers.

THE CHASE-SHAWMUT COMPANY, Boston, sent out the following notice on February 1, 1902: "We regret to say that a serious fire in our factory has completely crippled us, and we shall be unable to fill any orders for the present. We shall reconstruct our factory at once, and hope for a continuance of your esteemed favors."

THE HAINES & NOYES COMPANY, Chicago, Ill., has recently put on the market an improved type of central-energy, intercommunicating telephone, with non-packing transmitters, of heavy cast brass and bipolar, pony bell-type receivers, with water-shrunk hard rubber shell. Large contracts for these instruments have been closed throughout the country.

THE ALLIS-CHALMER COMPANY, Chicago, Ill., is sending out the seventh edition of catalogue No. 24. This book is printed and bound in the usual excellent style of the Allis-Chalmers literature. Besides describing in detail its line of Riedler pumps, this book contains much interesting information as to measurements and mechanical and engineering formulæ.

BULLETINS of free lectures to be delivered at the Baron de Hirsch trade school, 222 East Sixty-fourth street, have been issued. A course of eight lectures on electricity will be given on Wednesdays from January 8 to February 26, inclusive. Another course of lectures will be delivered in the St. Bartholomew's Lyceum Hall, 205 East Forty-second street, on the Saturdays beginning January 4 and ending February 15.

THE OSBURN FLEXIBLE CONDUIT COMPANY, 21 Park Row, New York city, reports an increasing demand for flexible conduit known as "Flexduct," the factory working night and day. Increased facilities for manufacturing are being arranged for, and it is probable that an additional building will be erected at an early date. The officers of the company are William H. Seaich, president and treasurer; C. E. Corrigan, vice-president and manager; H. G. Osburn, secretary.

THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, Chicago, Ill., has increased its factory floor space nearly 100 per cent, the idea being to allow the factory plant and general offices all on the main floor, so as to enable visitors to see the working of a model board as well as samples of the finished product. The company states that several large orders have recently been secured, notably a 3,000-line common battery exchange for Logansport, and a 2,000-line exchange for South Bend, Ind., and another large order from the Illinois Telephone Company, Jacksonville, Ill.

WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, New York—The retirement of Mr. B. H. Warren from the second vice-presidency has brought about the following changes in the organization: Mr. Frank H. Taylor, until recently fourth vice-president, has been advanced to the position of second vice-president, in charge of the sales, and will have a general supervision over its affairs. Mr. L. A. Osborne, manager of the works, has been made fourth vice-president, in charge of the engineering and producing operations. Mr. Arthur Hartwell, until recently manager of the Chicago office of the company, has been advanced to the position of sales manager in charge of the sales organization. Mr. Philip A. Lange, until recently general superintendent, has been made manager of works, in charge of the manufacturing department. The organization in other respects remains as heretofore: Mr. George Westinghouse, president; Mr. Ph. Ferd. Kobbe, third vice-president and treasurer, in charge of financial department; Messrs. G. W. Hebard and W. M. McFarland, acting vice-presidents; Mr. T. W. Siemon, assistant treasurer; Mr. A. M. Mattice, chief engineer; Mr. Charles F. Scott, chief electrician; Mr. B. G. Lamme, assistant chief engineer; Mr. James C. Bennett, auditor.

PERSONAL MENTION

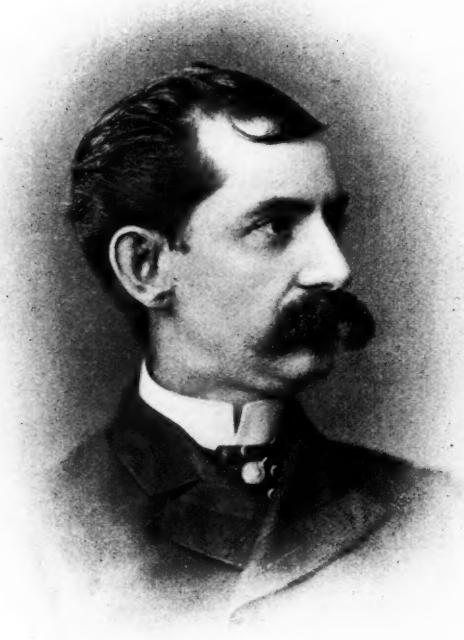
MR. W. R. BRIXEY, the electrical manufacturer who was severely injured in the Murray Hill Hotel, New York city, in the recent dynamite explosion, is much improved, and his physicians think he will be out in about three weeks. Mr. Brixey sustained a compound fracture of the skull.

MR. J. C. REILLY, formerly general superintendent of the New York & New Jersey Telephone Company, was made general manager of that company by vote of the board, and assumed office the first of last month. Mr. Reilly is one of the pioneer telephone men of the country, although a young man, and has been identified with some of the most progressive and substantial telephone construction in the country. His promotion is a proper recognition of ability and experience.

MR. E. B. BAKER, general superintendent of the Southern New England Telephone Company, was given a dinner in his honor, at the Allyn House in Hartford, on Friday evening, January 31. On that day Mr. Baker completed his twenty-fourth year in the telephone business. Mayor Alexander Harbison, of Hartford, presided, and among others present at the dinner were Judge A. C. Bill and Messrs. J. P. Harbison, George T. Manson, G. A. French, R. W. Sherman, A. H. Merrill, W. J. Martin, J. Crabb, J. A. Crilly, P. N. Fitzgerald and Captain W. L. Candee. The occasion was a very enjoyable one, and a beautiful shrine pin was presented to the guest during the evening as a token of the esteem of the gentlemen present. Mr. Baker has decided to retire from his present telephone work on May 1, but will probably continue to be identified with the electrical field.

MR. JAMES B. OLSON, the recently appointed manager of sales for the India-Rubber and Gutta-Percha Insulating Company, Yonkers and New York city, is well known in the electrical fraternity. His promotion is regarded as well earned, and, having been for many years associated with the late Mr. James W. Godfrey, is considered his logical successor. Mr. Olson has devoted his time and energy not only to the building up of a good trade connection, but also to a mastery of intricate technical details, and the firm is to be congratulated upon his continuance with them, which must inure to the welfare of its best interests.

J. B. OLSON.



GEORGE WORTHINGTON

FOUNDER OF THE ELECTRICAL REVIEW